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THE SCIENCE OF HAPPINESS

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people on the planet

Why meditation can
rewire your brain

The new drug to
treat depression

Can money
buy happiness?

Why pain can
make you happier

Do social networks
make you antisocial?

HOW TO

Beat the winter blues

Stress-proof your life

Take a tech detox

'Hygge' your home



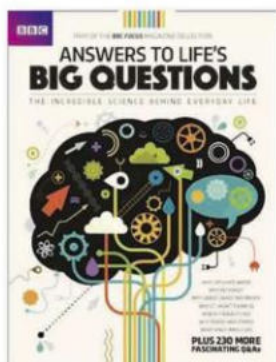
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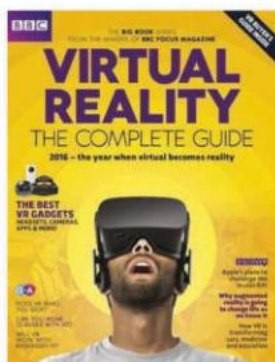
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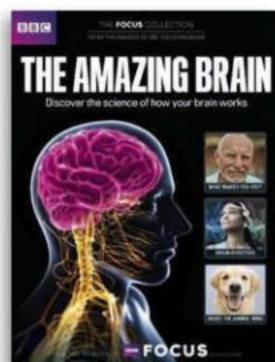
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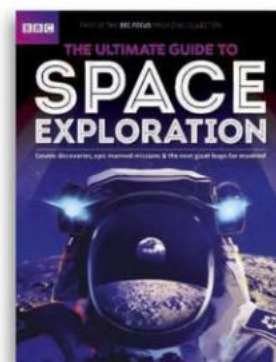
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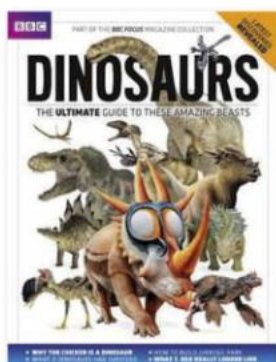
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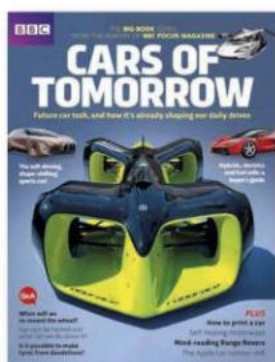
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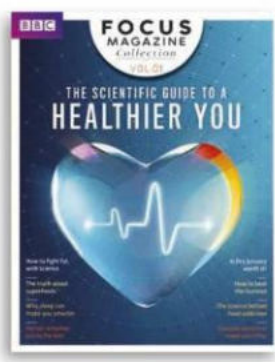
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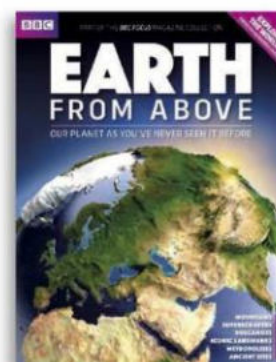
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**IMMEDIATE
MEDIA^{CO}**

The theory of happiness



Albert Einstein might be most well known for his theory of relativity, but maybe his theory of happiness is more useful to you and I. In a visit to Tokyo in 1922, Einstein jotted down his thoughts on happiness on some hotel stationery. Last year, the note sold for an incredible £1.19 million. (Who says money can't buy happiness?!)

So, what were his gems of wisdom that warrant such a price? "A calm and humble life will bring more happiness than the pursuit of success and the constant restlessness that comes with it."

Wise words indeed. Almost a century later and research is revealing why a calm and humble life really is the route to happiness. In this special edition, experts explain the strong link between lifestyle and mood: how cities affect mental health (page 20), how bacteria changes our emotions (page 28), why some pain is a good thing (page 36), and how social media could be making us miserable (page 38).

The experts also reveal what research shows about how to be happy – from what to spend your money on in your quest for happiness (page 46) to how to beat the winter blues (page 54), de-stress your life (page 58), 'hygge' your home (page 74), cope with depression (page 76), find your inner zen (82), and dance your way to a happy life (page 68).

Plus, on page 12, discover the happiest people and places on the planet... (It seems Einstein had the right idea living much of his life in Switzerland – see page 19.) Enjoy!

Daniel Bennett, Editor



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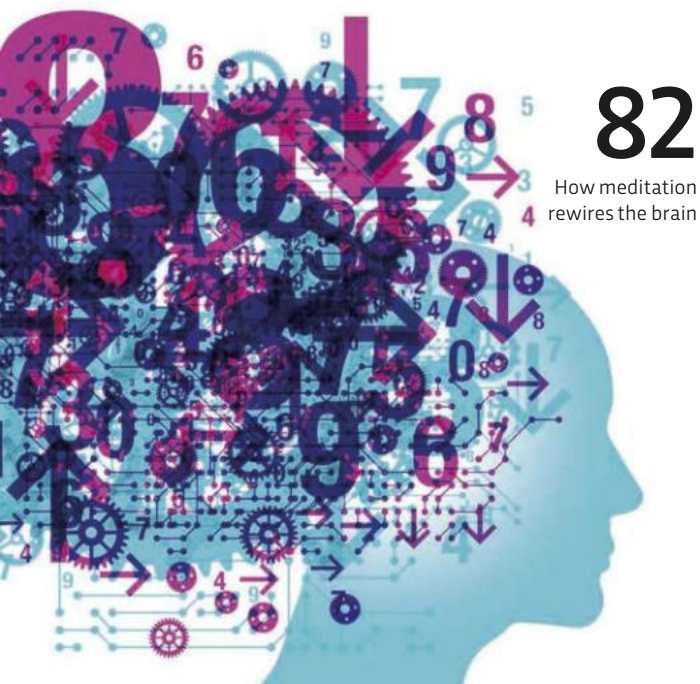
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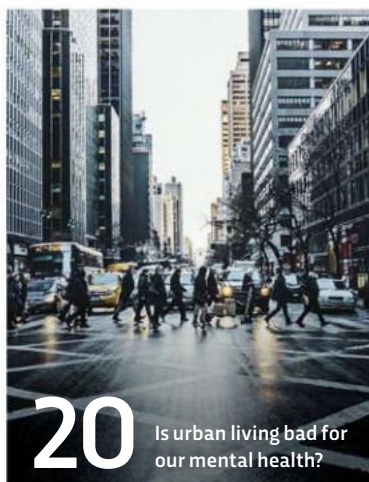
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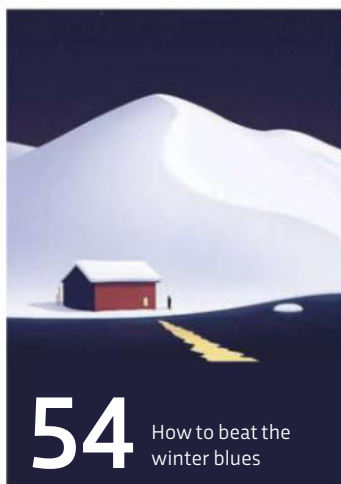
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HOW DO YOU FEEL?

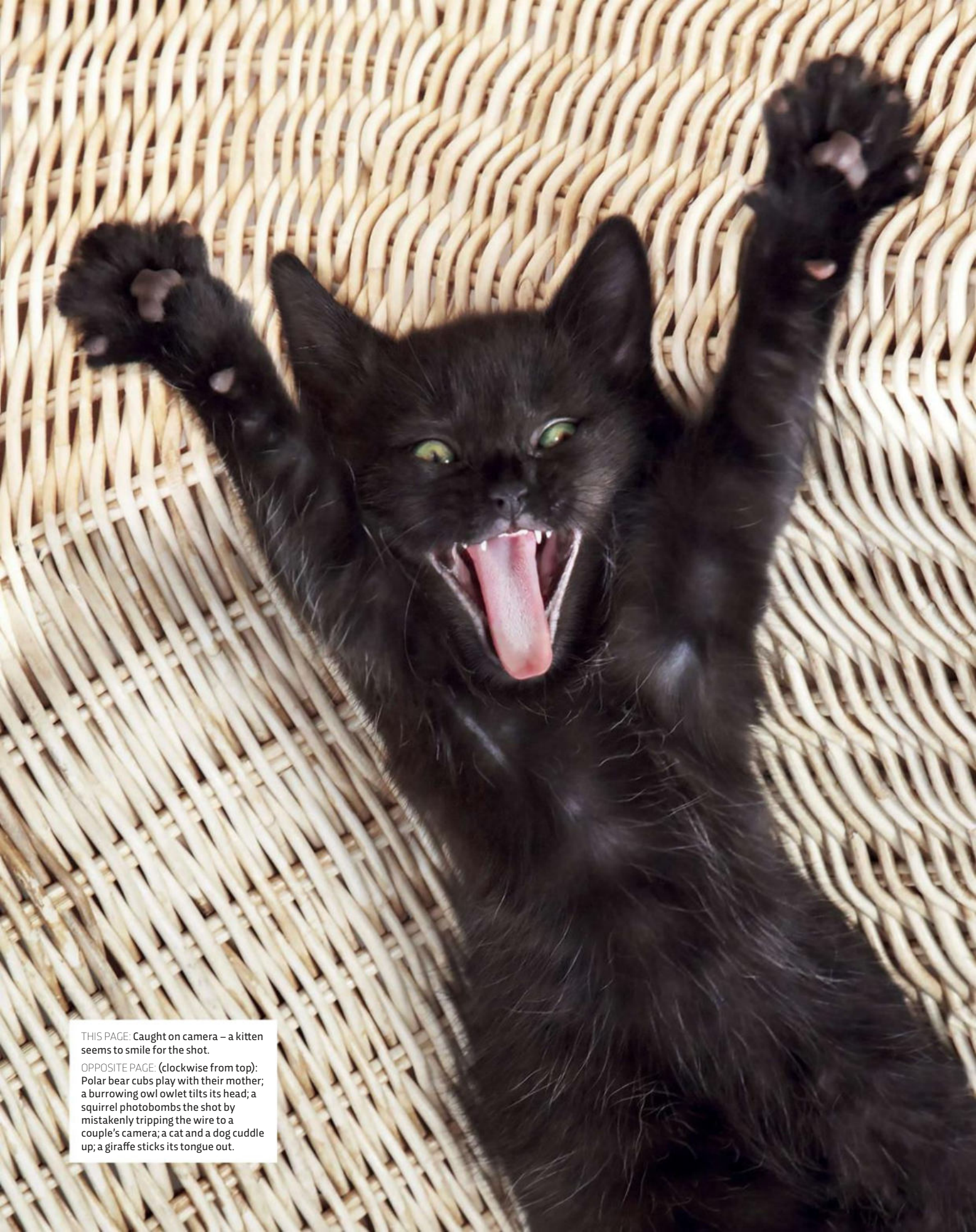
Warm and fuzzy inside? If so, you're not alone. Photos of animals doing funny or cute things often make people smile.

Numerous studies have shown that images of cute babies causes the release of the 'pleasure' chemical dopamine, which is also released when people take drugs, have sex and fall in love. Known as the 'baby schema' effect, dopamine is also released by visual cues in baby mammals, such as big eyes and a large head relative to body size.

Meanwhile, research into our relationship with dogs has found that levels of the 'love hormone' oxytocin rises when we're around our pet pooches. No wonder they're called man's best friend.

But why do we find animals doing human actions so funny, such as the giraffe sticking its tongue out? No-one really knows. Maybe it's the fact that their actions inflate our egos.





THIS PAGE: Caught on camera – a kitten seems to smile for the shot.

OPPOSITE PAGE: (clockwise from top): Polar bear cubs play with their mother; a burrowing owl owlet tilts its head; a squirrel photobombs the shot by mistakenly tripping the wire to a couple's camera; a cat and a dog cuddle up; a giraffe sticks its tongue out.

... AND HOW ABOUT NOW?

Feeling guilty? It's understandable. These images incite a lot of negative emotions. The reason is that we recognise all these animals are suffering because of human actions, whether that's directly harming the creatures through poaching, or simply through our resource hungry lifestyles – pumping out greenhouse gases that warm the planet or littering it with waste.

Guilt is a very human emotion, and it makes us decidedly unhappy – in fact, research shows that it plays a key role in depression. The good news is that studies have revealed it is key in promoting pro-social behaviour – it kicks most of us into action to do something good. So, what will these images encourage you to do more – or less – of?





THIS PAGE: A green sea turtle mistakes a plastic bag for a jellyfish. It is estimated that 300,000 tonnes (the weight of 1,500 blue whales) of plastic swirl around our oceans.

OPPOSITE PAGE: (clockwise from top): A sea duck (scoter) is rescued from a tanker oil spill in Pembrokeshire, Wales; global warming is being blamed for fragmenting Arctic ice forcing polar bears to fish ever closer to human settlements; only around 4,000 tigers remain in the wild, many are captured and sold on the black market; one of only three known critically endangered northern white rhinoceros being protected by armed guards; a monkey performs in Henan Province, China.

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ESS





HAPPIEST

MEET THE

PEOPLE ON THE PLANET

It's February. It's cold. Christmas is long gone and summer feels far away. So how, and why, do the world's happiest people keep smiling through the long winter months?

WORDS: JHENI OSMAN

Once again, it's been raining all day. It got dark hours ago. And a bitterly cold February night beckons in the city of Oslo. Many people would find all this pretty depressing. But not most Norwegians.

In 2017, Norway was ranked as the happiest nation on the planet in the World Happiness Report. This might sound surprising given that in mid-winter in some parts of the country the sun never rises, so people are deprived of that supposed vital ingredient of happiness: sunshine. So what's their secret?

The annual World Happiness Report typically assesses criteria such as life expectancy, people's freedom to make life decisions, generosity, social support, corruption in

government and business, and per capita income.

You might think that the latter is the reason that Norwegians are so happy – per capita income is high, in part due to the country's vast oil reserves. But, despite weaker oil prices, Norway shifted from fourth place in 2016 to first in 2017 (just beating last year's winner Denmark to pole position). The forward-thinking nation drills its oil slowly, investing the proceeds for the future, insulating itself from the boom and bust cycles that other resource-rich countries have suffered. This requires good governance, trust and generosity – all things that propelled Norway to the top spot.

"The most surprising thing we've found is that building the positives is more important than ➔

GETTY

identifying and curing the negatives,” says John Helliwell, professor emeritus of economics at the University of British Columbia. He co-edits the World Happiness Report and is remaining tight-lipped about who he thinks will take the number one spot this year – results are due in spring. “The aim of the report is to increase public and policy awareness of the importance and meaning of internationally comparable measures of the quality of life,” he adds.

Helliwell and his colleagues believe that happiness provides a better indicator of human welfare than separate measures of income, poverty, education, health and good government. And they have found that people are happier living in societies where there is less happiness inequality. However, results show that happiness inequality has increased significantly in most countries, in almost all global regions, and for the population of the world as a whole.

DOES MONEY BUY HAPPINESS?

It’s not surprising to learn that wealth does play a small part in happiness. After all, incomes are more than 25 times higher in the happiest countries than in the least happy ones. “Income is one of the bigger elements in explaining international differences,” says Helliwell. “Having at least sufficient material resources is one of the prime supports for a good life. But, of course, they are not the major part of the story.”

Meik Wiking, CEO of the Happiness Research Institute, a Copenhagen-based think tank, agrees that money is not the sole root of happiness: “The Danes decouple wealth and well-being. We focus on the small things that really matter, including spending more quality time with friends and family, and enjoying the good things in life.”

Wiking is the author of *The Little Book Of Hygge: The Danish Way To Live Well*. Hygge (pronounced ‘hooga’) entered our urban dictionary in 2016, encapsulating the ‘calm cosiness’ of Danish life. (Get ready, the Norwegian version ‘koselig’ could be the word of 2018.)

“Hygge has been called everything from the ‘art of creating intimacy’ to ‘cocoa by candlelight,’” says Wiking. “Some of the key ingredients are togetherness, relaxation,



People are happier living in societies where there is less happiness inequality, but it has increased in most countries

indulgence, presence and comfort. The true essence of hygge is the pursuit of everyday happiness and it’s basically like a hug, just without the physical touch.”

Now, before you start thinking that all you need to be truly happy is to win the lottery so that you can settle down in a blissful state of hygge and never lift another finger, think again. Even if you’re wealthy, work is a great tonic for gloominess.

“It is not work itself, but how it is done, with whom, and in what circumstances, that creates or destroys happiness,” says Helliwell. “People are happier doing things with other



Perks, such as early-finish Fridays and the great July shutdown, mean that Norwegians have plenty of spare time to enjoy the great outdoors

people, especially if they feel they're doing important things in a trustworthy and friendly environment. This is true for life both in and out of the workplace. People who work in a high-trust workplace and think of their superior more as a partner than a boss are as happy on weekdays as on weekends."

And there we were feeling miserable about the decades of hard toil that stretch ahead of us...

SUBJECTIVE SMILES

So, the next big question: can one really rate happiness subjectively? Surely, surveys are subject to individual bias? We all know how we Brits like to put a brave face on, picnic on a rainswept beach (just because the Met Office told us it was going to be a scorcher), and always say 'Fine, thanks!' when someone asks us how we are (even if we're going through a crushing bout of existential angst, having spilt our cup of tea).

"There are three different types of subjective well-being measures," explains Helliwell. "These include positive affect [how we experience positive emotions], negative affect

[how we experience negative emotions], and life evaluations, where respondents say how happy they are with their lives as a whole." According to Helliwell, life evaluations tend to be determined by individual circumstances and are more variable among countries. All three measures are subjective reports based on the individual's responses – just like when doctors ask patients to report on their pain levels.

Yet not all scientists are satisfied with these subjective assumptions. Associate professor Wataru Sato and his team at Japan's Kyoto University have used brain scans to try to determine which area is involved in feeling happy. Their results showed that volunteers who rated highly on happiness surveys had more grey matter mass in the precuneus, which is involved in self-reflection and consciousness.

But scientists aren't just looking at the brain. They are also turning to genetics to determine why some of us are happier than others.

IN THE GENES

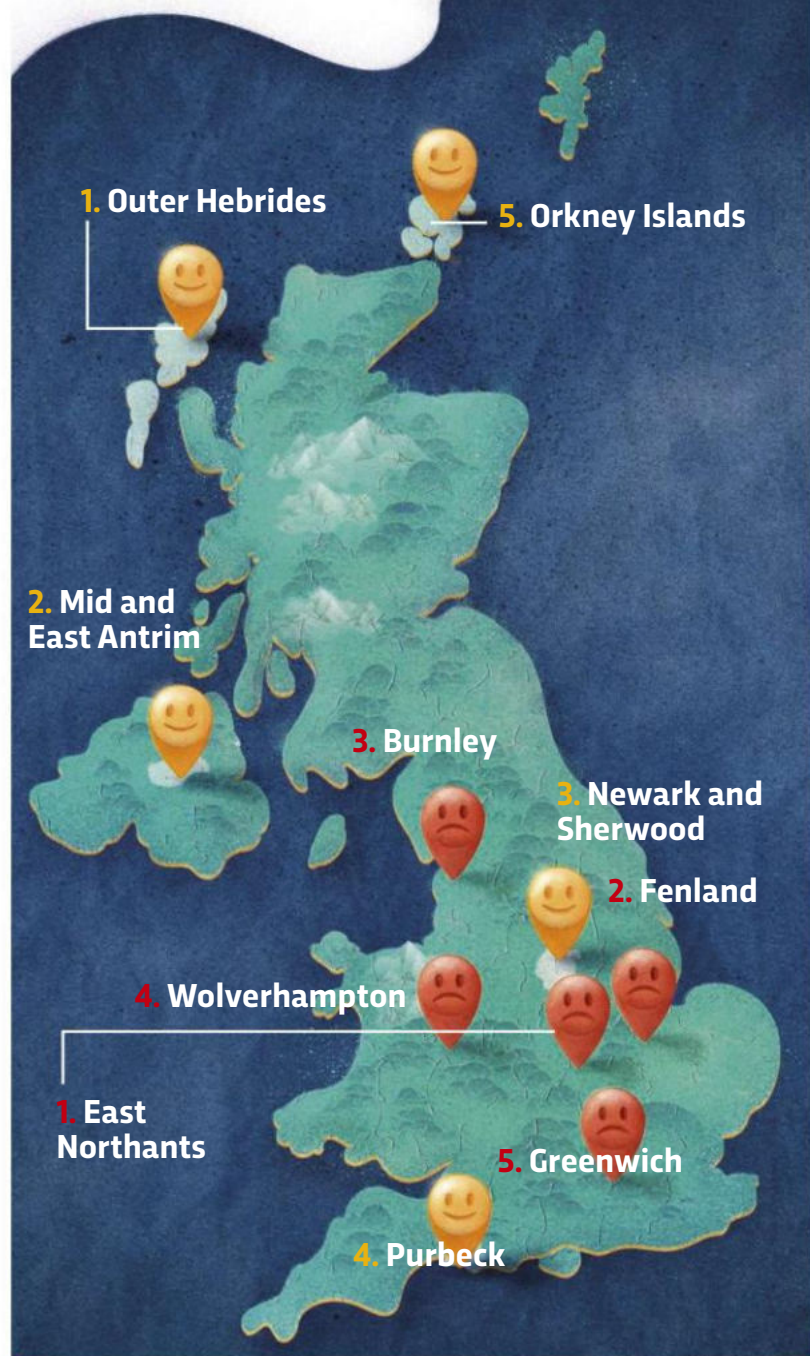
Researchers at Vrije Universiteit in Amsterdam have isolated the parts of the human genome that may explain the differences in how we each experience happiness. After analysing the DNA of over 298,000 people from around the world, the team found three genetic variants for happiness. Crucially, they discovered that two of the variants are linked with differences in the symptoms of depression.

"The genetic variants that influence subjective well-being largely overlap with those that explain differences in depressive symptoms," says Prof Meike Bartels, who carried out the research. According to Bartels, this overlap indicates that it could be useful to promote well-being in conjunction with preventing and treating mental illness. So it seems that taking steps to keep your population happy is just as important as safeguarding them from mental illness.

Meanwhile, a paper published in the *Journal Of Happiness Studies* suggests that the DNA of people who regard themselves as happy is more likely to contain a specific gene variant involved in sensory pleasure and pain reduction.

Elsewhere, research at the University of Warwick has shown that national levels

THE HAPPIEST PLACES IN THE UK



The Office for National Statistics wanted to find out the happiness levels of people in the UK.

Participants answered four questions, using a scale from zero to 10. Here, we've listed the UK's five happiest and five unhappiest places, which were ranked according to the results.

If you can't see your area then visit bit.ly/happy_area for a more in-depth map of the UK.

Do you live in the happiest (or unhappiest) area? Let us know your thoughts by sending an email to reply@sciencefocus.com or drop us a message on Twitter @sciencefocus



of happiness depend on how close we are genetically to the smiley Scandis.

“Our research showed that the ‘genetic distance’ of a country from Denmark correlates with the average life satisfaction in that country,” says Proto.

Intriguingly, the research also showed a link between mental state and the version of the gene that influences the uptake of serotonin. The serotonin transporter gene comes in two forms: long or short. According to the research, the short variation, which some scientists consider to be linked to depression, is more common in countries that report lower average levels of life satisfaction. While the link is controversial, the short variation has also been associated with higher scores on neuroticism and lower life satisfaction. Denmark and the Netherlands appear to have the lowest percentage of people with this short variation.

HAPPINESS IS LAW

The great news is that we British are not too far removed genetically from our Nordic cousins. “The British have no excuse – they are sufficiently close to the Danish in terms



LEFT: Spending quality time with friends and family is vital for happiness, according to research

BELOW: Economist John Helliwell thinks that happiness is a better measure of well-being than wealth or education



There's a link between mental state and the version of the gene that influences the uptake of serotonin

of genetic distance," says Proto, adding jokingly: "Although weather is also an important determinant of subjective well-being!"

Despite the weather, the Brits seem to be doing ok. Back in 2010, David Cameron commissioned a study into the happiness of the British and, according to the government, happiness rates are on the rise in the UK. Indeed, politicians across the globe have latched on to the importance of how happy citizens make for easy governance. Ministers of happiness have been appointed in Ecuador, the United Arab Emirates, Venezuela and Bhutan. In the latter, happiness is now embedded in the national constitution. And the National Academy of Sciences in the US has formed a panel to establish how happiness

measurements can help develop policy.

So, is the world becoming a happier place? "There's not much of a global trend yet," says Helliwell. "Data is only starting to become available for a long enough period to find significant trends among nations. Over the very long term, even if lives in less happy countries are becoming better, we might expect to see that for the world as a whole. There may be some adjustment in expectations as people raise their sights and see even better potential lives."

And that's the crux of it. It's human nature to always want more. After all, that's what has made us such a successful species. But, as research shows, to be truly happy maybe we need to think like our Nordic cousins and get a bit more *hygge* (or *koselig*) into our lives. **G**

Jheni Osman is author of *100 Ideas That Changed The World* and the *World's Great Wonders*, and presents *SciTech Voyager* and on Radio 4's *Costing the Earth*.



Find out where in Britain you'd be happiest, by taking this interactive test from BBC iWonder at bbc.in/1br6VME

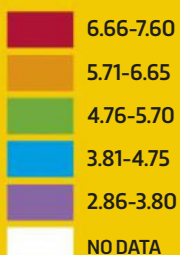
THE HAPPIEST PLAC

It looks like money does buy happiness – to a certain extent...

This map shows how many of the world's poorest countries are also the least happy. But there must be something good in having siestas and fiestas, as even some relatively poor nations in Latin America are just as happy as elsewhere on the planet. The US has slipped from third to 14th place over the last decade, which is being blamed on declining social support, and rising inequality and corruption. But the US still sits higher up the table than the UK, ranked 19th.

KEY

Self-assessed scores, where 0 equals worst possible life and 10 the best



FACT

After the global recession, the most extreme changes in happiness scores were experienced by Venezuela (-1.6) and Nicaragua (+1.4).

FACT

Newer EU member states tend to be less happy than older members, except for Greece (ranked 87), which is still suffering from high unemployment.

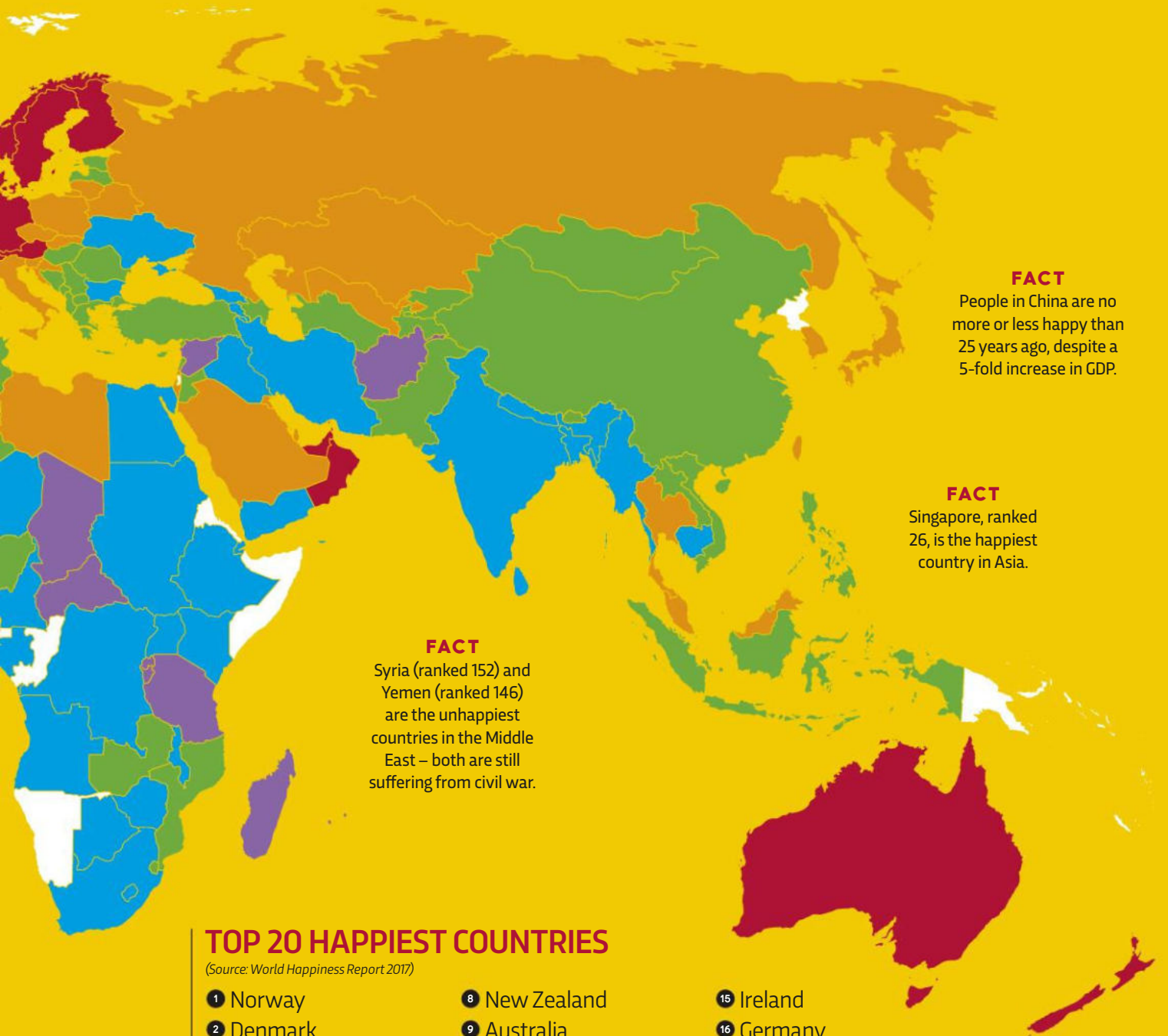
FACT

The unhappiest country in Europe is Ukraine (ranked 132), which is still recovering from the annexation of Crimea by Russia in 2014.

FACT

The unhappiest countries in the world are mostly in sub-Saharan Africa – Tanzania, Burundi and the Central African Republic rank as the three least happy nations on that continent.

ES ON THE PLANET



TOP 20 HAPPIEST COUNTRIES

(Source: World Happiness Report 2017)

- | | | |
|---------------|------------------|-------------------|
| 1 Norway | 8 New Zealand | 15 Ireland |
| 2 Denmark | 9 Australia | 16 Germany |
| 3 Iceland | 10 Sweden | 17 Belgium |
| 4 Switzerland | 11 Israel | 18 Luxembourg |
| 5 Finland | 12 Costa Rica | 19 United Kingdom |
| 6 Netherlands | 13 Austria | 20 Chile |
| 7 Canada | 14 United States | |



Are cities bad for our mental health?

According to the UN, almost two-thirds of us will live in cities by 2050. It seems their growth can't be stopped. But are they good for our health – or do they make us unhappy?

WORDS: BRENDAN KELLY

In 1950, 746 million of us lived in urban areas. By 2014, that had increased to 3.9 billion, or 54 per cent of the world's population. According to the UN, 66 per cent of us will live in cities by 2050.

There is much that is good about cities. They are highly efficient ways of focusing human activities such as business, education and research. Managed correctly, they offer substantial environmental advantages. Cities bring us into closer routine contact with other humans, and most of us seem hardwired to

seek out this enhanced level of contact: we like being in cities as much as we like being around people. But while we like cities, do our bodies and brains like them too? And would more of us be happier and healthier living in the countryside?

Our beloved cities are associated with increased rates of childhood asthma, heart disease, diabetes and various cancers, as well as childhood psychiatric illnesses, adult depression and even schizophrenia. Research into these disturbing statistics is best explored ➔

by looking at schizophrenia – surely the most enduring and mysterious malady in the history of medicine.

WHAT IS SCHIZOPHRENIA?

Schizophrenia affects approximately one per cent of the world's population at some point in life. Its causes are unknown and it is more common in men than women.

Symptoms start with subtle changes in childhood thinking and behaviour, but these are so vague that they are only recognisable in retrospect or in research studies. The vast majority of children do not develop psychological or psychiatric problems. Nonetheless, these subtle changes indicate that, for many people with schizophrenia, brain development takes a different pathway from an early stage, possibly even while still in the womb.

The first obvious symptoms emerge in the teenage years, and include anxiety, low mood, social withdrawal or a preoccupation with odd beliefs. These symptoms are felt by most teenagers (and many adults) at some point, so do not necessarily mean that the person is mentally ill. However, if they are present to a substantial extent they might identify a young adult who is at high risk of psychological or psychiatric problems.

The classical symptoms of schizophrenia, when they eventually emerge, include delusions and hallucinations. Other features include difficulties with clear thinking and a range of 'negative' symptoms similar to depression – low mood, loss of interest, depleted energy and persistent social withdrawal.

While there has been much research into the biological underpinnings of schizophrenia, the disorder still remains one of the true enigmas of medicine. This is partly because 'schizophrenia'

is really a term used to denote a cluster of symptoms that tend to occur together, rather than a biologically defined entity. This places schizophrenia in sharp contrast to conditions such as diabetes, which is biologically defined by measurement of blood glucose, or brain tumours, which are diagnosed with brain scans. There are no blood tests or brain scans for definitively diagnosing schizophrenia. Nonetheless, there is growing evidence that dopamine, a key neurotransmitter in the brain, is abnormally regulated in schizophrenia. Given the highly interconnected nature of the brain, other neurotransmitters are sure to be involved too.

There is also a strong genetic element to schizophrenia, and there are likely to be multiple genes of moderate or small effect, which have yet to be fully understood. Moreover, it remains stubbornly the case that most people with schizophrenia do not have a family history of the disorder, and most people with a family history do not develop

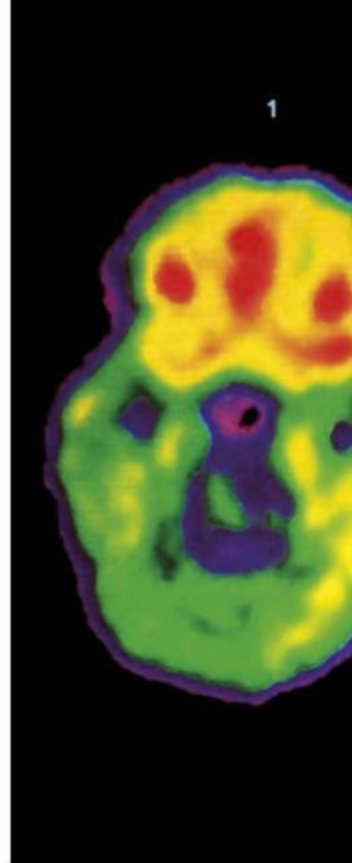
schizophrenia. Therefore, while family history and genes increase the risk of schizophrenia, environmental factors are critically important too. And this, finally, brings us to cities.

SCHIZOPHRENIA IN THE CITY

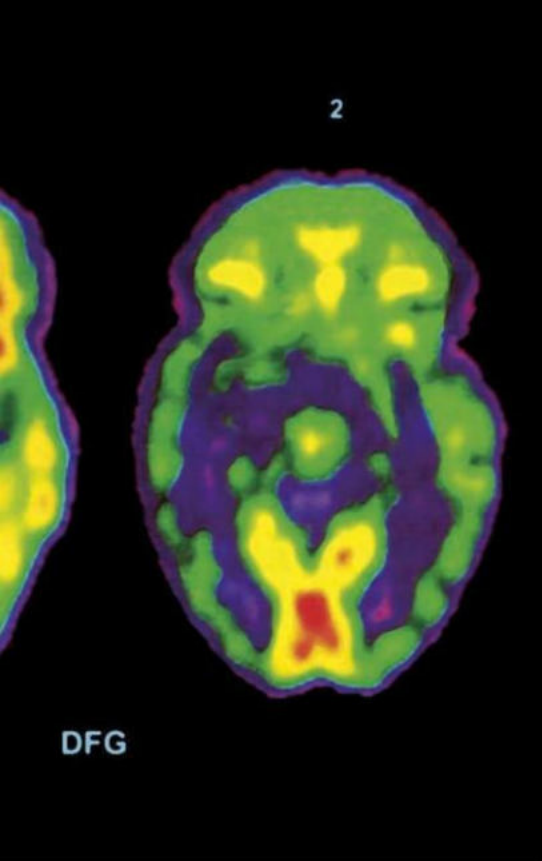
Studies of the distribution of schizophrenia around the world have long recognised that the condition is more prevalent in urban areas than rural ones.

Research that took place back in the 1960s and 1970s showed that the most obvious explanation for this turns out to be at least partly true: people who have pre-existing schizophrenia tend to move to urban areas to seek out assistance, accommodation and support, leading to a relative

Schizophrenia is more prevalent in urban areas than rural ones – cities are associated with an increased risk of people developing the condition



GETTY, SCIENCEPHOTO LIBRARY X2



LEFT: A scan of a healthy brain (left) compared to a schizophrenic brain (right) during an attention test. Red shows high activity, green and black (low activity)

BELOW RIGHT: Young people born in a city environment have an increased risk of developing conditions such as schizophrenia. One factor that could contribute towards this is a higher baseline cortisol level in the body

BELOW LEFT: Cortisol is produced by the adrenal gland in response to stressful situations

concentration of schizophrenia in cities as a result of the disorder.

It soon transpired, however, that this 'urban drift' effect was not of sufficient magnitude to entirely explain the association between schizophrenia and cities. Various other factors were at play. Studies from the 1970s onwards shed further light by demonstrating repeatedly that, even after taking 'urban drift' into account, cities are associated with a substantially increased risk of people developing schizophrenia. The more methodologically sound and larger the study, the greater the risk associated with cities.

The scientific literature now definitively shows that urban birth, urban upbringing and urban living are all associated with an increased risk of subsequent schizophrenia. ●



Just like having a family history of schizophrenia, exposure to urban environments appears neither necessary nor sufficient for developing the disorder, but it does increase the lifetime risk from one per cent to approximately two per cent, using the best available estimates. This increase in risk is not nearly enough to advise against living in a city, even among those who have a family history or other risk factors for schizophrenia. So don't move house – at least not yet.

But the fact that such a small risk is identified so consistently by different research groups, using different methodologies, in different locations, at different times, makes it unlikely that the finding is due to chance alone. Moreover, in terms of causality, there's not only a strong correlation between cities and schizophrenia, but there's also evidence of a dose-response effect: the greater the degree of urbanicity at birth, the greater the risk of developing schizophrenia.

There's clearly something at work here, some unidentified biological or psychological factor associated with cities that alters brain

development or function to increase the risk of schizophrenia. But what is it?

SEARCHING FOR THE SOURCE

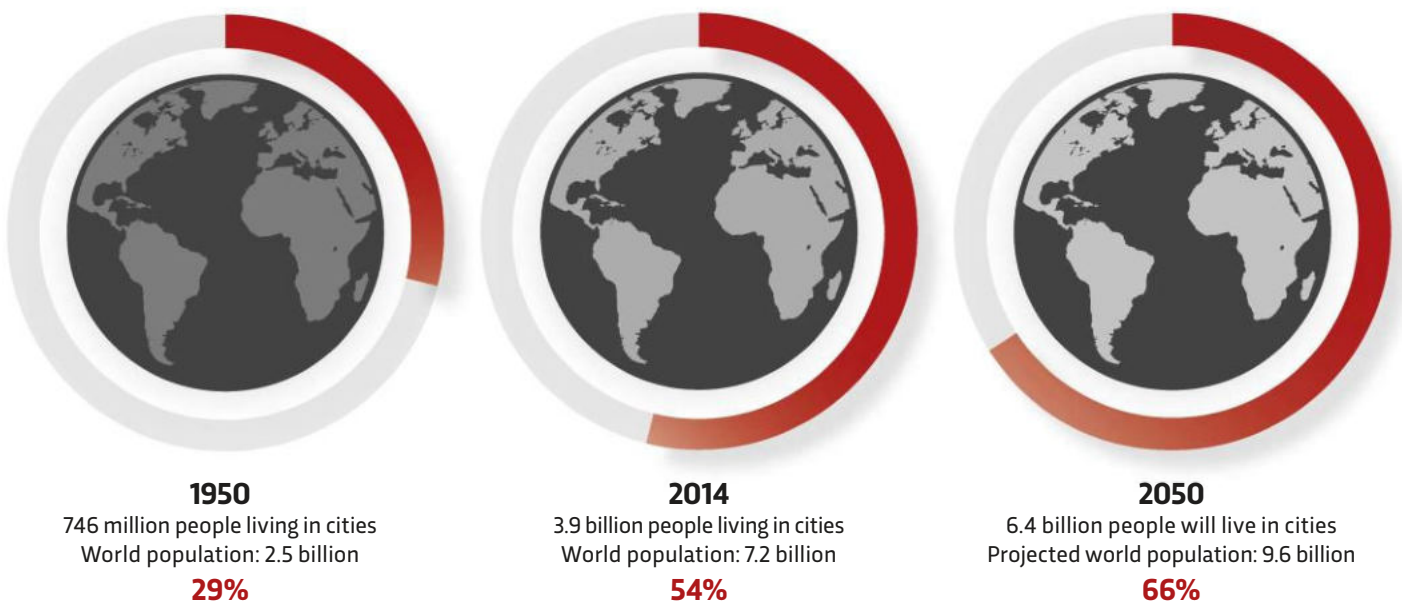
There are multiple suggested explanations for the link between cities and schizophrenia. For example, there is long-standing evidence that if a mother becomes unwell during pregnancy, such as coming down with influenza, then it might increase the baby's risk of developing an illness or disorder as a young adult.

Another theory is that cities increase people's exposure to cats and, by association, cat-borne infections such as toxoplasmosis. It appears that if there is an association between cats and schizophrenia (and that's not yet proven), it's independent of the link between cities and schizophrenia. Other possible explanations for higher levels of schizophrenia in cities include increased exposure to air pollution and more incidences of vitamin D deficiency. But these, too, remain unproven.

As interest in this field soared during the 1990s, several possible explanations were ruled out. It's now clear that the increase in

RIGHT: Cities offer an efficient way to live our lives, but they can put our health at risk

How many people live in cities?







risk is not closely linked with socioeconomic groups in childhood, household overcrowding, parental lower income, parental unemployment, increased cannabis use or the number of older siblings. So what theories are left?

Some of the most compelling schizophrenia research in recent years links increased risk of the disorder with 'community disorganisation' and its associated social, psychological and biological effects. For example, it is known that migrants experience increased rates of many mental disorders, including schizophrenia. Why? Psychiatrist Dr Jane Boydell and colleagues have shown that the smaller an ethnic minority group is, the greater its increase in risk. In other words, the size of any ethnic minority group operates as a buffer against the increased risk of schizophrenia: the larger the group, the lower the risk. Are these social risk factors having a greater impact in cities than elsewhere? And, if so, what is the reason for this effect?

Many psychiatric disorders, including schizophrenia, are associated with disturbances of the body's stress responses. This is reflected in levels of cortisol, which is a steroid hormone that's produced by the adrenal gland in stressful situations. Chronic production of high levels of cortisol has a damaging effect on virtually all body systems, including the brain. It's possible, and even probable, that belonging to a small migrant group is associated with a state of chronic stress, producing increased baseline cortisol and therefore increased risk of schizophrenia.

There are reasons to believe that this kind of 'stress effect' is more powerful in urban areas because city living affects the brain's response to stress. Baseline levels of crime, social fragmentation and urban decay are also important. This model, linking community factors with effects on individual brains, received strong support in a study by Duke

ABOVE: A combination of factors contribute towards higher schizophrenia levels in city environments

Chronic production of high levels of cortisol has a damaging effect on virtually all body systems, including the brain

University and King's College London, published in *Schizophrenia Bulletin* in May 2016. A team of researchers from the two institutions analysed data from over 2,000 UK-born twins and found that reduced social cohesion and crime victimisation likely explain, at least in part, why children in cities have an increased risk of developing symptoms of disorders such as schizophrenia. It is not the cities themselves, then, but the way we live in them that appears to matter most.

This is an exciting finding that is both consistent with previous studies and robust enough to add extra weight to the idea that community disorganisation is closely linked with whatever biological mechanism connects cities with schizophrenia. But while the research is clearly heading in the right direction, it still remains unclear what any of this will mean for the treatment and prevention of schizophrenia.

WHAT NEXT?


There are many pharmaceutical, psychological and social treatments for schizophrenia, and these help patients and families a great deal. It's critical that these treatments are delivered efficiently, effectively and with compassion, to heal and empower the mentally ill and their families. But these treatments are deeply imperfect and are not cures for schizophrenia. The prospects of better treatment would be much improved if we understood precisely what causes schizophrenia in the first place. But, for the time being, we do not.

In the search for answers, it's critical to develop a better understanding of urbanicity and – even more so – its relationship with other risk factors, such as genes, prenatal or birth injury, psychological trauma, cannabis use,

head injury, migration, social adversity, chronic stress and others. All are of these linked with schizophrenia to varying degrees, but none of them are fully understood.

Ultimately, research is hampered by the fact that schizophrenia is defined by symptoms rather than biological tests. 'Schizophrenia', like 'fever' or 'headaches', is almost certainly an umbrella term that covers a family of different but related 'sub-disorders', rather than a single, biologically distinct entity. These sub-disorders, despite sharing many symptoms, might well have somewhat different origins in different groups or individuals.

As a result, schizophrenia retains the ultimate mystery that is intrinsic to all true scientific enigmas: it might not exist as a definable entity. The undeniable suffering of people diagnosed with schizophrenia may well reflect different combinations of risk factors producing similar – but not identical – collections of symptoms.

In this context, the link between schizophrenia and cities is, perhaps, not so surprising. Cities are complex, intricate entities, difficult to define, hard to explain and yet remarkably enduring throughout recent human history. Cities, in other words, are a lot like schizophrenia. And, as schizophrenia tends to go hand in hand with unhappiness, identifying the causes of the condition and how we can minimise these in urban life will help create healthier and happier communities. 

Brendan Kelly is professor of psychiatry at Trinity College Dublin. He is the author of numerous books, including *Mental Illness, Human Rights and the Law* (RCPsych Publications, 2016).

To find out more about schizophrenia and other mental illnesses, visit rethink.org



HOW BACTERIA CHANGE YOUR MOOD

Tiny organisms in your gut may be messing with your mind. Find out how this new area of research could help you be happier

WORDS: NICOLA DAVIS

Bacteria. For many it's a dirty word, suggesting a horde of tiny invaders to be obliterated with a lemon-fresh spray. Yet the staggering truth is that you're more bacteria than body – your gut alone holds over 100 trillion bacteria of myriad species, many of which help with breaking down food and play a vital role in immunity.

Most of your gut microbiota (the microbe population living in your intestine), including bacteria, initially came from your mother's birth canal as you entered the world or from skin and the surrounding environment if you were born by caesarean. Once you're out in the open, multiple factors such as

diet, antibiotics, genetics and stress will influence your microbiota. The upshot is a cornucopia of bugs that weighs about the same as a human brain. And perhaps that's fitting, for while it's long been known that the brain can influence the gut, modern science is showing that communication can go both ways. Indeed, recent studies have revealed that the gut microbiota could be involved in a host of conditions such as obesity, social behaviour deficits, Parkinson's disease and anxiety. That's right – microbes might be meddling with your mood.

It's a hot topic of research that exploded about a decade ago when a team of Japanese researchers delved into the gut microbiota of mice. But these weren't any old mice. They were raised in a ➔

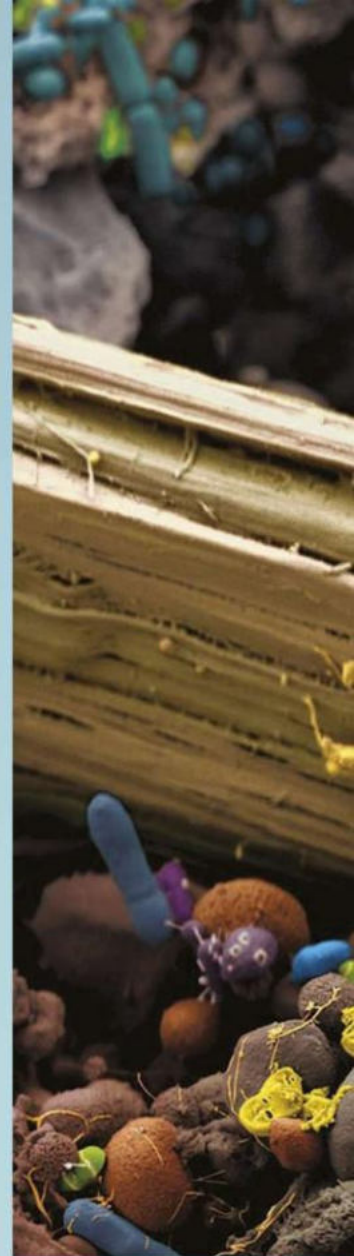


Studies have revealed that the gut microbiota could be involved in a host of conditions

sterile environment, making them 'germ-free'. This created a clean slate with which to study their brains and behaviour before and after bacterial colonisation. The researchers found that the germ-free mice had greater amounts of stress-related hormones when restrained than animals with microbes. Yet when germ-free mice were colonised by certain bacteria, their stress response changed. The germ-free mice also showed differences in the levels of a brain-derived neurotrophic factor (BDNF) protein – a substance in the brain that affects the survival, growth and connection of neurones.

A wave of research involving germ-free mice followed. One intriguing study was carried

out by Dr Jane Foster and her colleagues from McMaster University in Canada. Using a cross-shaped maze, they found that germ-free mice spent more time hanging out in exposed areas than their bugged-up peers. This suggested reduced levels of anxiety, despite having increased levels of a stress-related hormone. Furthermore, the germ-free mice showed changes to the levels of BDNF-encoding molecules, which suggests the gut microbiota might tinker with how the brain is wired for anxiety. "We know what brain regions are involved and what's interesting is those brain regions are changed in these manipulations of microbiota," says Foster.



ABOVE: Intestinal bacteria help us to digest food and absorb nutrients

LEFT: Prof John Cryan is studying the other effects these microscopic organisms have on our physiology



The relationship between microbiota and behaviour is far from simple, however. Changes to levels of BDNF-encoding molecules appear to differ between sexes. Meanwhile, a recent study using one strain of rat found that the animals appeared to behave in a more anxious way when they didn't have gut microbiota. Studies have also found that infecting mice with populations of 'bad' bacteria can increase their anxious demeanour.

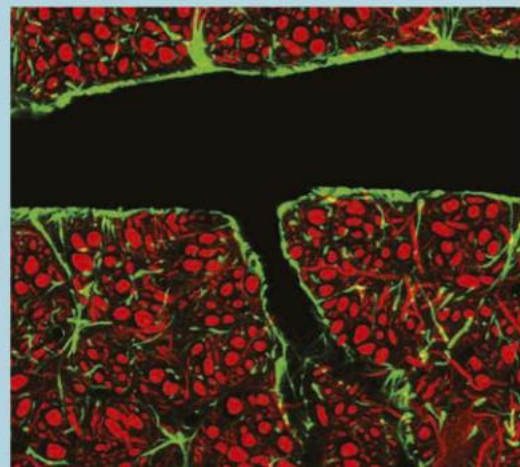
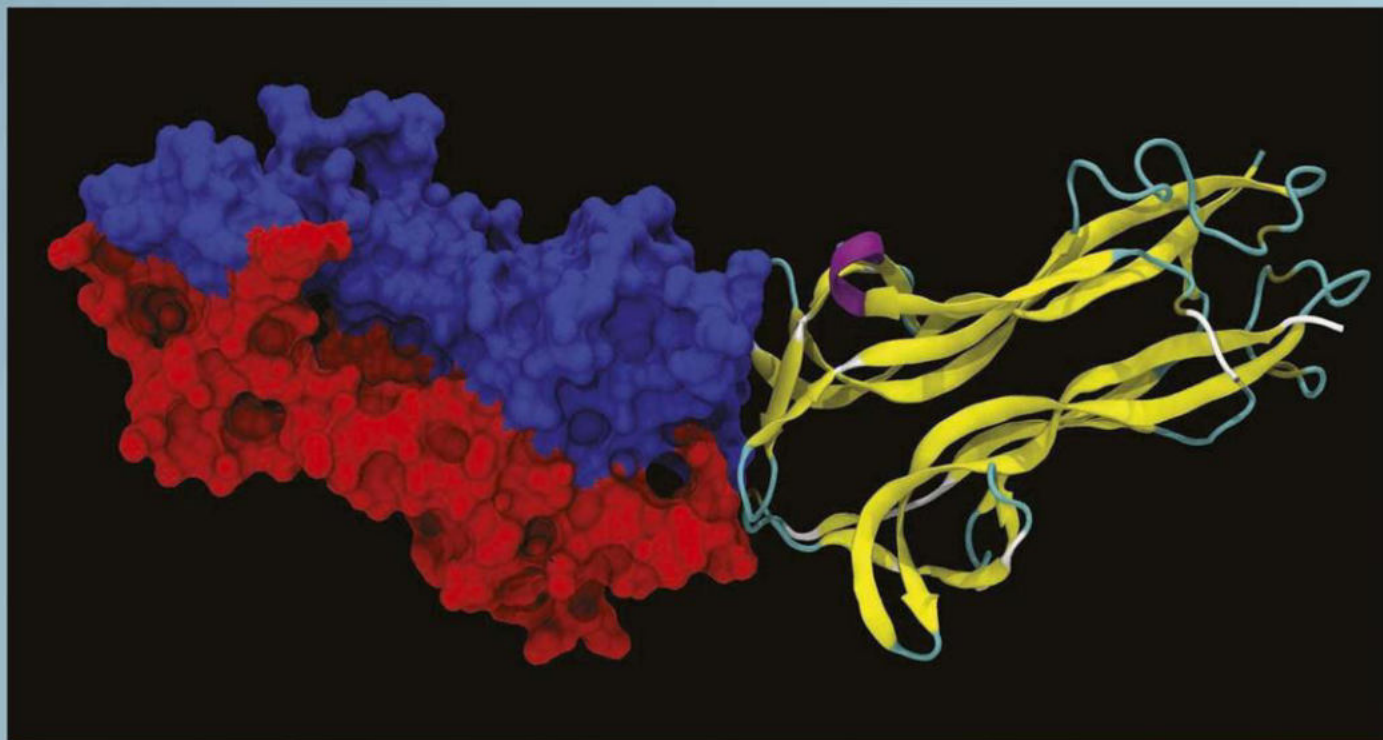
BUGGING OUT

Nevertheless, the notion that bugs can affect behaviour is pretty mind-boggling. In one of the most astonishing studies, a team of researchers transferred gut microbes from an anxious strain of mouse into a germ-free mouse

100
trillion bacteria are
found in the gut

of a more adventurous strain – and vice versa. The result? A behaviour transplant.

Yet questions abound, especially regarding the significance of age. Indeed, some studies suggest that stress responses and anxiety levels in germ-free mice can only be altered by colonisation with bacteria if such exposure occurs when the animals are young. If the same effect is observed in humans, it could imply a need for interventions in childhood and pre-adolescence. Interestingly, the composition of our own gut microbiota is unstable until we reach about three years of age. "It's just developing and that's also the same period of life when the brain is developing," says Professor Emeran Mayer, a gastroenterologist at the University of California, Los Angeles. ➔



CLOCKWISE FROM TOP:
Brain-derived neurotrophic
factor (BDNF); section
through a blood vessel
in the brain; germ-free mouse
taking part in a study to
monitor stress hormones



Interventions in elderly people might also be important because our gut bacteria levels start to decline as we age. “The microbiota composition, diversity [and] abundance kind of reverses back to the way it was in childhood,” says Mayer. “So it’s quite possible that any manipulations or any influence on brain function will be greater at that time.”

Exactly how the gut microbiota bring about changes to the brain and behaviour is far from clear-cut. “If I have a headache, it could be because I bumped my head or it could be because I’m dehydrated. Those are two very

different mechanisms where the readout is the same,” says Foster. “It is the same thing here.”

And the mechanisms are myriad. Among the mooted possibilities, gut bacteria – or the molecules they produce – could directly or indirectly interact with branches of the vagus nerve in the gut. They could signal to the brain, affect hormonal signalling routes, interact with the immune system or trigger responses via pathways that include neurones within the gut lining and the vagus nerve.

What’s more, just a few years ago, researchers revealed that the

gut microbiota could affect the permeability of the blood-brain barrier. It's a web of intrigue.

MOOD SWINGS

"There are so many different types of bacteria and they are all having very different effects on different aspects of physiology," says Professor John Cryan from University College Cork.

In one study, scientists at McMaster University in Canada joined forces with Cryan and his team to probe the impact of the probiotic *Lactobacillus rhamnosus* on healthy mice. "It dampened down anxiety and made the animals more chilled out [and] changed the brain chemistry," Cryan explains. "When we cut the vagus nerve this didn't happen." But complexities are never far away. "Some of our colleagues in Canada have done similar studies with different bacteria and showed that it wasn't dependent on the vagus," he adds.

There is a tantalising suggestion that various bacteria species might influence mood in humans

It's a problem worth investigating. While human studies are few and far between, there is a tantalising suggestion that various *Bifidobacteria* and *Lactobacillus* species might influence mood in humans as well as rodents. In one trial, healthy people that were given a blend of such probiotics for 30 days were found to fare better in questionnaires concerning their perceived levels of anxiety, depression and stress than those who were given a placebo.

But that doesn't mean we should be stocking our shelves with probiotics just yet. "For me, taking a probiotic is akin to saying 'I'll take a drug'," says Cryan. "You might take a statin for cardiovascular disease, but you wouldn't take it if you had depression – that's where we are with ➔




3 micrometres is the size of a *Lactobacillus* cell

SMALL BUT MIGHTY


Bacteria measure just a few micrometres across and are even smaller than red blood cells

Bacteria are typically made up of just a single cell each, but these cells are very different to those that make up the human body. Bacterial cells do not have a membrane-bound nucleus. And besides chromosomal DNA, bacteria can have 'extra' little loops of DNA called plasmids. They also lack membrane-bound organelles such as mitochondria – the 'batteries' of our own cells – and nearly all bacteria cells possess a cell wall.

Some bacteria are able to harness light energy, while others make use of chemical reactions involving organic or inorganic compounds to fuel processes in the cell. Bacterial cells are typically just a few micrometres (μm) in length. *Lactobacillus* cells, for example, are around $3\mu\text{m}$ long. Our own cells, however, can vary in size quite widely. Red blood cells are typically $7\mu\text{m}$ in diameter. And ova, the largest human cells, can reach $120\mu\text{m}$ – roughly the width of a human hair.



Lactobacillus
 $3\mu\text{m}$



Red blood cell
 $7\mu\text{m}$



Human hair
 $120\mu\text{m}$

1 μm = 1 micrometre = 1 millionth of a metre

probiotics. We need to get more precise about which bacteria are doing what and why.”

OF MICE AND MEN

While it's still early days, Cryan foresees a future of ‘psychobiotics’ – probiotics that could be prescribed to help treat people suffering from mental health conditions. Taking substances that promote the presence of ‘good’ gut bacteria, known as prebiotics, might also prove beneficial.

“I think there is a hope that in future people will, in addition to getting their blood taken when they go to their GP, also get a snapshot of their microbiome,” says Cryan. That, he believes, could lead to the prescription of probiotics, perhaps in parallel to other treatments.

Foster is cautious. “Until we have some evidence that the microbiome is different in different mental health disorders – and how it is different – we can't really talk about how relevant what we are learning in the mice is to people,” she explains. There are significant differences between mice and men, including the fact that the human brain boasts a very different prefrontal cortex to that of a rodent. This will affect the ways in which the gut microbiota may function. “If your microbiota send a signal to lower-lying brain areas, the mouse doesn't have much to compensate for that and it exhibits a particular behaviour,” says Mayer. “In humans, these layers of prefrontal cortex can compensate and make up for it.”

BELOW: *Lactobacillus casei* is found naturally in the human mouth and intestines. It's often added to yoghurts



BBC
RADIO



Learn more about the
microbes inside you on
A Natural History Of Me!
<http://bbc.in/2D9fY3g>

DNA

is present inside
bacteria cells

As Mayer has found, gut bacteria do appear to have some impact on the human brain. In one small study funded by dairy product manufacturer Danone, Mayer's team split a cohort of healthy women into three groups. One group was given a probiotic yoghurt, one a probiotic-free dairy product and the other nothing at all. The women's brains were scanned using functional magnetic resonance imaging (fMRI) at the start of the experiment, then again after four weeks of taking the intervention. The study found that there were differences between the three groups in the connectivity of various brain regions when resting. But when the women were asked to match images of angry or frightened faces to similar pictures, the probiotic group showed a decrease in the activity of brain regions involved in emotion and sensation. It was a surprise. "I didn't expect it," says Mayer candidly. "I was a sceptic in the beginning of all these animal studies. They just seemed too outlandish – it

The probiotic group showed a decrease in the activity of brain regions involved in emotion and sensation

GUT FEELING

Probiotics and prebiotics have alleged health benefits for us. But what are the differences between them?

Prebiotics are substances that we can't digest, but are believed to promote 'good' bacteria in the gut. Prebiotics occur naturally in some foods and include carbohydrates, such as fructo-oligosaccharides, galacto-oligosaccharides and inulin.

Probiotics are live microbes that are thought to bring a health benefit. They are often administered as liquid drinks, yoghurts or tablets. Some of the most studied probiotics are of the genera *Lactobacillus* and *Bifidobacterium*.

The health benefits of probiotics are specific to each strain and different products contain different strains of bacteria. Commercial products in the EU are banned from using the label 'probiotics' as the health claims of such products have not been approved, but manufacturers are allowed to list the strain of bacteria included.

According to market researchers BCC Research, the global market for such products is expected to grow to around \$36.7bn (£24bn) this year.



seemed like it just didn't fit into our paradigm of brain-gut interactions." But, he points out, there's more to do. "It would be nice to repeat a study like the one we did, possibly in a population with anxiety so that we can determine [whether] these brain changes seen with the probiotic are also correlated with subjective changes in anxiety."

Exactly how big an influence microbes have over our mood has yet to be determined, but Cryan believes we might be surprised by the extent of it.

"It's worth considering that they are the master puppeteers," he says. **F**

Nicola Davis writes about science, health and environment for *The Guardian* and *Observer*

WHY PAIN MAKES YOU HAPPIER

Generally, pain is something to be avoided – we tend to equate happiness with feeling comfortable. But, in his new book, psychologist Brock Bastian argues that pain might just be the hidden ingredient to a fulfilled life

INTERVIEW: JAMES LLOYD

The main idea in your book is that we need some pain in our lives...

Happiness has become a focus of Western culture, and for many of us seeking it, it's an important goal in life. But we can't have endless happiness. That's actually quite a banal idea. We need the painful, negative experiences to know what happiness is – they give definition and meaning to our lives. We need to accept the negatives rather than try to medicate or eradicate them all.

We usually want to get rid of pain. What's the downside of eliminating it?

We're good at designing painkillers to take control of our pain, and in the developed world, we're more comfortable than ever, at least in the physical sense. But we're becoming too comfortable. Our ability to cope with discomfort is decreasing, and we sometimes feel like we shouldn't have to deal with pain at all. A study has shown that taking painkillers not only reduces our negative experiences, but also our positive experiences. It seems that numbing our access to pain also numbs our access to pleasure.

We need contrast in life. A holiday is enjoyable if we've had to work hard for it. Food tastes especially good after a hike. By engaging with adverse or difficult experiences we increase our capacity to access pleasure in life. Yet,



Brock Bastian thinks that the pain of the ALS Ice Bucket Challenge contributed to its success

GETTY

our societies tend to devalue these types of experiences. Our research at the University of Melbourne has shown that living in a society which expects us to be happy all the time actually seems to be driving depression. One of our studies involved tracking participants over a month as they kept daily diaries, and we found that social expectations were a central feature in people's depressive symptoms.

What are the benefits of pain?

Obviously it serves a physical function, telling us to take our hand away from a hot stove, but it also has more psychological benefits. For example, it prompts us to reach out to others. In 2011, while I was researching this topic, there were huge floods in Brisbane, and 55,000 people came out to help with the clean-up.



“By engaging with adverse or difficult experiences, we increase our capacity to access pleasure in life”


So pain also makes us more generous?

About 12 months before the ALS Ice Bucket Challenge went viral in 2014, a study showed that people were prepared to donate more to charity if they'd just dunked their hand into ice-cold water. It was as if the pain gave more meaning to the act of giving. I doubt the Ice Bucket Challenge would have been so effective if people had been throwing confetti over themselves. And pain also makes us more resilient. Research shows that the more we have to endure in life, the better we get at coping with it.

How about chronic pain – surely that can never be a good thing?

No, I'd never want to pretend that anyone who's in chronic pain should be grateful for their experiences. I was invited to talk at the British Pain Society in front of anaesthetists who treat chronic pain, and was a bit concerned at how my message would come across. But people were really interested in how this broader perspective can give people tools to respond to their pain. Even in chronic cases, some of the positive effects of pain can sometimes still be present.

How can we put your ideas into practice?

First, we need to not pretend that our negative experiences are not there. Sometimes life sucks – failure happens. The next step is to understand what these experiences can offer us. We don't run marathons for the pleasure; we run them for the pain. The joy of passing an exam is meaningless without the possibility of failure. Finally, we need to embrace and engage with these experiences more. I'm not saying we need to cause ourselves harm – pain is not the same as harm. But a lot of pleasure in life comes from pushing ourselves and exposing ourselves to risks. I think that's the key to a meaningful life. 

Brock Bastian is an Associate Professor in the School of Psychological Sciences at the University of Melbourne, and author of *The Other Side of Happiness: Embracing a More Fearless Approach to Living*



Do social networks make us antisocial?

Many of us have experienced the ways in which social media has changed the online world. But should we be worried about it altering our behaviour and making us unhappy?

WORDS: DEAN BURNETT

Recently, I witnessed the nasty breakdown of a relationship. One partner accused the other of infidelity and promiscuity; the other retaliated with claims of emotional abuse, drunken behaviour and an inability to perform sexually. All this, in much more sweary language than that conveyed here. It got unpleasant fast, with children being dragged into it, and friends taking sides and furiously rowing with those who'd taken the other side. All very grim, and it made me

vow to avoid any and all of those involved as a result. That wasn't difficult though, as I'd never actually met any of them to begin with. This whole breakdown happened on Facebook. Some friends of friends had asked to add me to their network, I'd unthinkingly agreed, and thus I ended up with a front-row seat to their hideous break-up. Ironical, that a social network was essentially responsible for the destruction of so many social bonds.

You've no doubt heard many complaints about social networks before. They're time-

GETTY

consuming, invasive, confusing, compromise your privacy and so on. But do they actually make us antisocial? Is there any credibility to that claim?

If, like many do, you draw a clear line between online interactions and real-world interactions, with more importance being placed on the latter, then yes, arguably there is. But to really get to the heart of the matter, you have to look at how social networks affect our behaviour and actions towards other people. They can and do have significant impacts on these things, because of the way our brains work. The truth is, our social interactions, both online and in person, have a huge effect on our thinking and cognition. The social brain hypothesis, first put forward in the '90s by anthropologist

Robert Dunbar, suggests that our sociable nature is why we have such big brains to begin with. The argument is that primitive humans banded together in communities, and this cooperative approach proved very useful for our survival. But this lifestyle requires a lot of information to be processed; who do you trust? Who will help you? Who owes you favours? And so on.

A substantial amount of detail needs to be available at a moment's notice. Basically, you need a lot of grey matter to maintain this. That's the theory, anyway (and there are others).

In support of this, brain imaging studies have shown a network of regions, including cortical midline structures and temporo-parietal junctions, which show increased activity when the subject contemplates being part of a group. Areas like the ventral medial prefrontal cortex and anterior cingulate cortex show increased activity when processing our sense of self, our identity, and when processing awareness of the groups or communities we feel we're part of. This all suggests our social interactions are a major part of our identity.

The truth is, our social interactions, both online and in person, have a huge effect on our thinking and cognition

Humans need social interactions. Depriving humans of social contact, as when prisoners are sent to solitary confinement, is recognised by psychologists as a form of torture. On the other hand, too much social interaction isn't good either. Social interaction is mentally taxing: engaging with someone is a lot of work for the brain, as it requires mental effort. This explains the apparent contradiction between humans needing social interaction, but also needing privacy. Social interaction wears our brain out, so we need privacy to get away for a bit and 'recharge'.

All this shows that the brain strikes a precise balance to ensure we get the most from our social interactions. But just as putting 10 times the amount of sugar into a cake doesn't make it

10 times better, so social networks can amplify relationships and aspects of socialising in ways that are not helpful, but harmful.

As early as 2010, psychiatrists were arguing that social network addiction was a real phenomenon that should be classed as a clinical disorder, citing a case study of an individual who spent five hours a day checking Facebook,

rarely leaving the house to do so, losing jobs and in one case interrupting the therapy consultation to check their updates – tantamount to opening a beer during an AA meeting. It essentially means cutting off all other forms of social contact to focus solely on social media, to the detriment of your overall existence.

There are explanations for this. A successful social interaction means we experience a real-world reward in the brain. Oxytocin release gives a general sense of well-being, and the mesolimbic reward pathway (buried deep in the centre of the brain), releases dopamine, giving a rush of pleasure. Some argue – and a few studies even provide some evidence – that a successful social interaction online, such

RIGHT: Compared with other animals, including our closest relatives, we are quite friendly

BELOW: We can control how we portray ourselves online by only posting the best videos and images



GETTY X2



as a popular Facebook post or widely shared tweet, can also produce this positive response in the brain.

Unfortunately, these social ‘hits’ are a lot easier to get online, without all the effort of ‘normal’ social interactions. Drugs of abuse operate on similar principles, triggering the reward pathway, but without the hassle of actually doing the action that the brain would consider deserving of a reward. Over time, the brain adapts to expect these pleasurable signals, and does things like disrupt the areas responsible for inhibitions or conscious self-control to keep them coming. Indeed, a 2013 neuroimaging study at the University of Zurich led by psychologist Dr Katrin Preller revealed that cocaine addicts have diminished activity in areas like the orbitofrontal cortex, resulting in reduced emotional empathy and willingness to socialise. So if social network addiction is exploiting similar mechanisms to cocaine addiction, then social networks may well have a negative impact on a person’s ability to socialise, rendering them more antisocial. More research is needed.

CONTROL FREAKS

Another issue is that people have a greater deal of control over their interactions online, meaning they can decide, to a much greater degree, how others experience them. You can put up only good photos, delete unwise comments, spellcheck, share smart memes and so on. This satisfies an underlying process the brain engages in known as ‘impression management’, where we’re constantly compelled to present the best possible image of ourselves to others, in order to make them more likely to approve of us.

A 2014 study led by the University of Sheffield’s Dr Tom Farrow looked at impression management. Using scanning technology, the team asked subjects to choose behaviours that would make people like them, and that would make people dislike them. Activation was recorded in regions including the medial prefrontal cortex, the midbrain and cerebellum, suggesting that these brain regions are involved in processing the image of ourselves we want to present to others. ➔



However, these areas were only noticeably active when subjects tried to make themselves look bad – that is when they were choosing behaviours to make people dislike them. If they were choosing behaviours that made them look good, there was no detectable difference to normal brain activity. Coupled with the fact that subjects were much faster at processing behaviours that made them look good as opposed to bad, the conclusion was that presenting a positive image of ourselves to others is what the brain is doing all the time. It's the brain's default state.

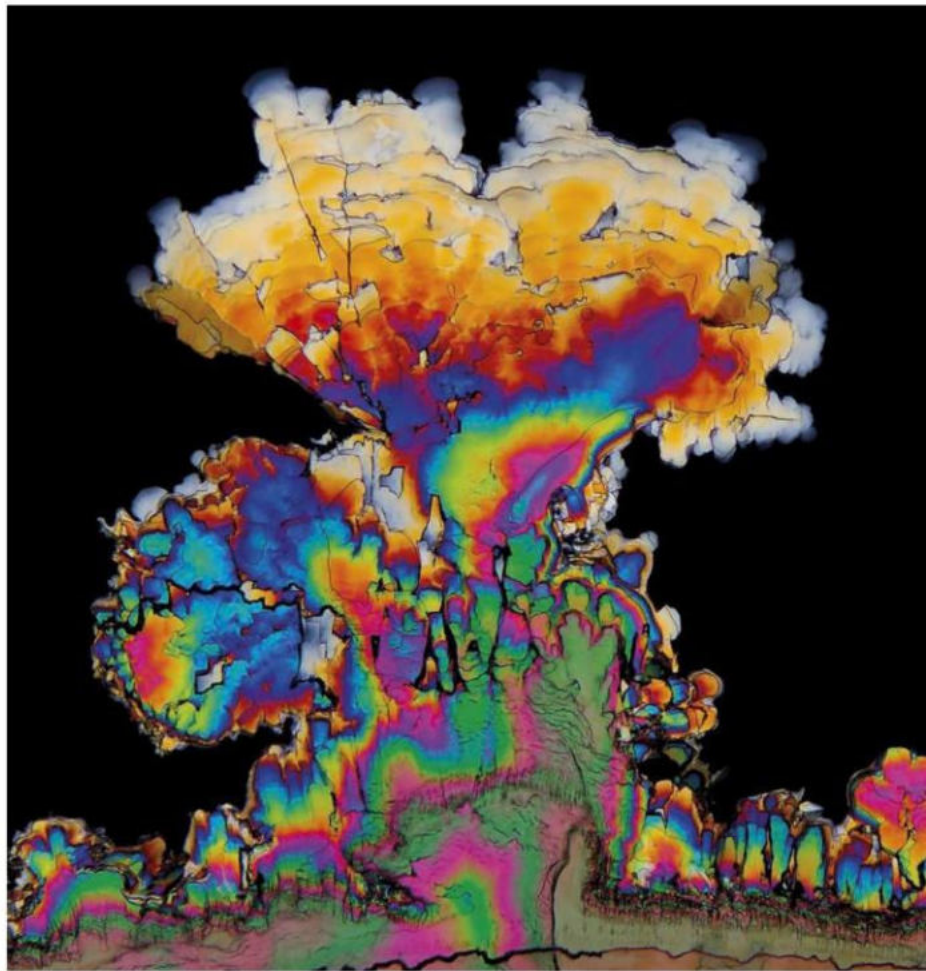
Granted, it was a small and limited study, but it's an interesting outcome nonetheless. And if we're constantly focused on presenting a positive image of ourselves, it's no wonder social networks are so popular, as they offer a much greater sense of control of how we come across.

PSYCHOPATHIC TRAITS

But this control is a double-edged sword. Even if you're just sitting with friends, the tendency to check your phone rather than talk can be overwhelming. The brain is usually averse to risk, preferring predictable options over less certain ones, and the cool, calm interface on the screen is often subconsciously more reassuring than the chaotic conversation going on around you. The people you're with may consider this behaviour antisocial. And rightly so.

More worryingly, a 2015 survey of men aged 18-40 by Jesse Fox and Margaret Rooney in the journal *Personality And Individual Differences* revealed that the amount of time spent on social networking sites, posting selfies and, revealingly, editing selfies to make them look better, was correlated with traits like narcissism and psychopathy. This isn't to say social networks cause these things, but they offer an outlet, a way for them to be expressed free of consequence, where they may otherwise be criticised or challenged, thus ensuring more socially acceptable behaviours.

Another intriguing finding, from a 2015 study led by Prof Joy Peluchette at Lindenwood University in the US, was that certain types of behaviour on social networks – namely 'openness' and extroversion – actually increase the



The amount of time spent posting and editing selfies correlates with traits like narcissism and psychopathy

odds of being a victim of cyberbullying. It may sound counterintuitive, but it makes a certain amount of sense. A person may typically keep their more flamboyant or expressive natures suppressed, because social norms deter such things. Subtle signs of discomfort in those around you, awkward body language and responses, muted atmospheres... these all act to keep gregarious or overly personal tendencies in check, to some extent.

However, such cues aren't present online, so you can be as overly expressive or personal as you like on there. But other people may find this unsettling or off-putting, or could see it



LEFT: Dopamine is released by the brain when we enjoy a successful social interaction, giving us a rush of pleasure


RIGHT: Social networking can trigger reward pathways in the brain, and may lead to addiction

as cynical attention-seeking. Either way, they react aggressively, and attack the person. But social networks also protect the attacker from the consequences of their actions, introducing a distance and degree of anonymity between themselves and their victim, shielding them from the immediate effects, but supplying the same 'rush' of having lowered someone's status and boosted their own. So social networks again become a way to facilitate and perpetuate antisocial actions.

Social networks also give us the ability to pick and choose what we see and hear from others, meaning we can end up in the oft-cited 'echo chamber'. Social networks make it much easier to form groups, and constantly remain part of them. This can give us more 'extreme' leanings, making us more intolerant of contrasting views as we grow unused to encountering them. What should be a casual meet-up in a pub can easily become a blistering row about a football team. Antisocial behaviour, caused by social networks.

It's not all doom and gloom. More nervous or

socially awkward people can be liberated by the controlled and organised communication offered by social networks, and friendships and relationships can form across the world now that would never have been able to exist before. But the truth is, for all that it may sometimes not work well, the human brain has evolved a variety of systems to make sure social interaction happens as efficiently as possible. Social networks, though, throw many spanners in the works, causing overall disruption, which can sometimes mean they end up achieving the opposite of what they're built for, and making people antisocial.

Like and share this article if you agree! 

Dean Burnett is a doctor of neuroscience at Cardiff University and author of *The Idiot Brain*. He tweets from @garwboy



Read a BBC iWonder article about why social media seems 'fake' to some people at bbc.in/2c86Grt

HOW TO BE **HAPPY**

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Listen to *In Pursuit of Happiness* to find out whether you can learn to be happy <http://bbc.in/2D6FRk5>

HOW TO BUY HAPPINESS

Richer countries with higher GDPs tend to be happier places to live, which suggests that money can buy you happiness. But the key is knowing how to spend your money wisely. Discover the surprising new science of smarter spending

WORDS: ELIZABETH DUNN AND MICHAEL NORTON

ALL ILLUSTRATIONS: DALE EDWIN MURRAY


Many people say it, but few believe that money can't buy happiness. After all, have you ever met anyone who's refused a raise? And yet, decades of research show that the relationship between income and happiness is convoluted. A 2010 Princeton University study of almost half a million Americans found that once individuals

were earning \$75,000 (£49,000) per year, additional income had no bearing on their day-to-day happiness. In fact, how much money you make may matter less than what you do with the money you have.

A tide of new research provides insight into how to use money in happier ways, whether you have a little or a lot. So read on to find out how to spend your way to a happy life. ➔



BUY EXPERIENCES



Nicole Mantie, 37, and her husband Dean, a couple we met during our research, dreamed of going on safari in Africa. But they'd bought a house with a bathroom in a dire state, so they figured the safari would have to wait. After hearing their friends' stories of a magical five-star safari, though, they decided to go for it – bathroom be damned.

While it's tempting to judge splurging on a safari as less sensible than investing in a better bathroom, a decade of research reveals the wisdom of their decision. Studies show that people get more happiness from buying experiences than from buying material things because experiences are more likely to bring us together with other people, whereas material things tend to be enjoyed alone. Research carried out by the College of Business at Stony Brook University, New York, found that a solitary experience made no more difference

to a person's happiness than purchasing a physical item.

Experiences also make for better stories. In one study, researchers from the University of Colorado found that pairs of strangers enjoyed talking more when they discussed experiential (versus material) purchases and ended up liking each other better. Nicole giddily recounts getting kissed by a giraffe while on safari. No matter what your stance on inter-species saliva swapping is, you can't deny that it makes for a more interesting story than fitting a new loo.

THE EXPERIENCE CV

Some people seek out extreme activities to add to what researchers call an 'experiential CV'. In Kenya, Nicole and Dean stayed at a hotel where guests are regularly woken up by a buzzer in the middle of the night. That might ruin a holiday for most people, but Nicole and Dean



were thrilled. They wanted to see ‘The Big Five’ (elephant, rhino, cape buffalo, leopard and lion) and the buzzer would sound to alert them to the animals’ presence.

Recent research conducted at Cornell University shows that people are much less likely to regret buying experiences than material things. The researchers asked students to recall past purchases and describe their biggest regret. When it came to material purchases, most students described something they regretted buying. But for experiential purchases, over 80 per cent said they regretted not buying when they had the chance and said it’s because experiences seemed irreplaceable, so they felt more remorse letting them pass by.

While Nicole’s bathroom remains unrenovated at the time of writing, she says, “I wouldn’t trade my memories of that trip for anything in the world. Not even a brand new home.” ➔

For a happy life, build up your ‘experience CV’ – a safari will provide you with good memories long after the paint has dried in a new kitchen



“Focusing on time, rather than money, pushes people towards happier activities”

Aside from enabling you to go on holidays, money can also transform the more mundane moments of daily life. One of us (Mike) hates doing the dishes. A study by psychologist Daniel Kahneman showed that housework ranks, unsurprisingly, among the least enjoyable of activities. But new research by Kahneman suggests that our moods depend more on what we do with our time and whom we spend it with than on the broader circumstances of our lives. So, rather than buying fancier cars and bigger houses, we're better off using our cash to reduce the amount of time we spend on things that decrease our happiness on a typical day.

TIME IS MONEY

After one of us (Liz) had a baby, she found herself awake most nights with the sleepless infant. Having tried every sleep-training strategy on the internet, Liz called in a woman named Claudia with a reputation for being able to teach any baby to sleep. Claudia didn't come cheap – for about the same price Liz could have bought the new speaker system she'd been eyeing for months. But by teaching the baby how to sleep better, Claudia did something that a speaker system never could – she transformed Liz's disturbed nights into hours of blissful sleep.

Many of our purchases have little bearing on how we spend our time on a typical day. But it's easy to inflate the potential benefits of a tantalising new purchase. This is amplified by comparison shopping, which can make a 10-speaker system seem far better than a six-speaker system and well worth the extra £200. Researchers at the University of Chicago found that when people try to visualise how these differences will make their lives happier,

A new speaker system or more free time? Studies show that having more free time will make you happier in the long run

they over-inflate the benefit those extra four speakers will bring them.

So, when contemplating a new purchase, apply the Tuesday Test: consider how it will affect the way you spend your time next Tuesday. Research shows that this simple thought exercise eliminates our tendency to overestimate how much any one thing will affect our happiness.

Thinking about how purchases will affect your daily life turns decisions about money



BUY NOW, CONSUME LATER

It's not just what you buy but how you buy that matters too. It's always tempting to whip out the plastic in a shop, or take a new product home today and pay for it later in monthly instalments. But debt creates a serious drain on happiness. A study of over 2,000 people by researchers at the University of Sheffield found that individuals with unsecured debt were significantly less happy than those who were debt-free.

We prefer to offset payments because paying in smaller amounts feels instinctively better. But, neuroeconomists have found that there's an actual 'pain of paying' that we attempt to avoid. Scientists from Stanford University discovered that shoppers inside an MRI scanner experienced a pattern of brain activity akin to stubbing a toe when they were shown a retail item with a high price. So even though it may feel worse at the time, paying up-front to avoid debt paves a better pathway to happiness.

While delaying payment isn't such a great idea, delaying consumption can be a boon for happiness by allowing us to enjoy the pleasure of anticipation. When researchers from Breda University in the Netherlands tracked the happiness of more than 1,000 holidaymakers in the weeks before and after their trip, they found that people actually experienced their biggest mood boost before departure. Looking back on a pleasurable experience can make you happy, but looking forward to it is even better. ➔

into decisions about time. This shift comes with a hidden bonus: focusing on time, rather than money, pushes people towards happier activities. In a study conducted at a café in Philadelphia, researchers asked people to think about time or money. Those with money on their minds ended up working more while at the café, whereas those prompted to think about time devoted more of their stay to socialising, one of the happiest activities in most people's days.



MAKE IT A TREAT



Less is more when it comes to treating yourself

We can often get more happiness from not only delaying consumption, but reducing it altogether. To explore this idea, the psychologist Jordi Quoidbach asked chocolate lovers to come to his lab and eat chocolate on two occasions, one week apart. During the intervening week, he instructed some of them not to eat chocolate but sent others home with a big bag of chocolate and told them to eat as much as they could. At the second tasting, the abstinence group got the most pleasure from eating chocolate. This study upends the assumption that getting more of what we like makes us happier.

This observation holds true in the real world too. A group of motorists with cars ranging in price from \$400 (£286) to \$40,000 (£28,623) were asked by researchers from the University of Michigan to recall the last time they'd driven their car and rate how much they enjoyed the drive. The researchers found there was no relationship between a car's value and how much enjoyment the driver got out of it. But when the same group was asked about the last time they'd driven their car just for fun, owners of more expensive models were much happier. So, the occasional treat can make the extra money you spend translate into extra happiness.



Don't spend it all on yourself
- give yourself a happiness
boost by spending your
hard-earned cash on others

Strange ATMs recently appeared in cities around Spain. The machines gave out envelopes filled with €100, no card or PIN needed. The only requirement: people using the ATM had to click 'yes' when asked if they were willing to spend the money on others. After coming across one of these machines planted by Coca-Cola, people used the windfall in a variety of ways. Some of their good deeds were captured on video: a young man left a tricycle on a child's doorstep, another handed theatre tickets to an elderly couple in the park. These small acts of generosity succeeded in embodying Coke's marketing ploy: 'share happiness'.

Coke's free money machines are reminiscent of an experiment we conducted some years ago. One of our graduate students Lara Aknin approached people in Vancouver, Canada, and offered them \$5 or \$20, which she asked them to spend by the end of the day. She told half to spend the money on others and half to spend



the money on themselves. That evening, we got in touch with each person to ask about their day. Those who spent the money on others felt happier than those who'd spent it on themselves.

Of course, it's rare that ATMs or students shower you with money. But research shows that spending money on others will provide happiness even when you use your own hard-earned cash. In fact, the warm glow of giving emerges even in poor countries where many people struggle to meet their own basic needs. This suggests the tendency to experience joy from giving might just be a fundamental part of human nature.

THE GIFT OF GIVING

If this is the case, even young children might get pleasure from helping others. To test this idea, we teamed up with developmental psychologist Kiley Hamlin. We started by giving toddlers Goldfish crackers. Their faces lit up when

Joy from giving might be a part of human nature

they received the fish-shaped treats, but they were even happier when they got the chance to give these treats away to a friendly puppet.

If you've ever seen a toddler dissolve into fits of tears after being asked to share, you might be wondering whether kids – or adults, for that matter – always experience joy from giving to others. Our research shows that such joy is not inevitable. You're most likely to feel good about giving when you can see how your generosity has made a difference for someone else. In the case of the toddlers, they got to see the puppet making happy munching noises after getting their Goldfish. [F](#)

Elizabeth Dunn is a professor of psychology at the University of British Columbia in Vancouver

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HOW TO BEAT THE WINTER BLUES

For sufferers of SAD (seasonal affective disorder), short days bring bouts of depression. But new research shows there's more to it than a lack of sunlight

WORDS: LILIAN ANEKWE ILLUSTRATION: THOMAS DANTHONY



Many people feel gloomy at this time of the year. The days are short and the weather is bad. But for almost four million people in the UK – about six per cent of us – these ‘winter blues’ can deepen into a depression called seasonal affective disorder (SAD) that occurs every year and worsens as the winter progresses. But new research is revealing that it could be more than a lack of sunlight that’s affecting sufferers’ moods.

Those who have SAD often sleep more than usual or have difficulty sleeping. They can feel lethargic, anxious or irritable and experience mood changes. SAD may even weaken the immune system.

“People with SAD are on a spectrum of how much it interferes with their ability to function,” says Dr Natasha Bijlani, consultant psychiatrist at the Priory Hospital in Roehampton. “But one of the key factors that distinguishes SAD from other types of depression is that there seems to be a link with light deprivation: people with SAD usually show a favourable response to bright light therapy.”

Our bodies use sunlight to regulate our circadian rhythm – the usual 24-hour cycle of our mood, sleep, appetite and energy levels. It’s thought that sunlight stimulates a region in the hypothalamus in the brain called the suprachiasmatic nucleus (SCN). Dr Bijlani describes it as “like a pacemaker in the brain that controls the sleeping and waking cycle.”

The conventional thinking is that when our eyes perceive daylight, the cells in the retina send a signal to the SCN, which then transmits

a message to the pineal gland in the brain. The pineal gland is sometimes referred to as our ‘third eye’ because it reacts to produce less melatonin when we are exposed to light. At night, or when there is a lack of bright sunlight, this process is reversed and our bodies produce more melatonin, which makes us feel sleepy and lethargic. This process is thought to be linked to the effects seen in people with SAD. It would also explain why light therapy – using a light box to expose sufferers to very

bright light – can be an effective treatment for many people.

SAD sufferers can have lower levels of serotonin in the winter. This has been linked to increased appetite and eating more than usual. In fact, a 2014 study in *Psychiatry Research* found that 27 per cent of people with SAD binge ate during winter.

New research suggests that light deprivation during the wintertime only partially explains SAD

SHEDDING NEW LIGHT ON SAD

New research suggests that light deprivation during winter only partially explains SAD. Scientists in northern Norway – where there are just a few hours of sunlight a day during winters that last for many months – have found that depression in winter is no more common than in other countries.

So what other factors might play a role? Research by Dr David Kerr, associate professor of psychology at Oregon State University, provides some clues. Kerr and his team tracked over 700 people’s moods at different times of the year for 19 years, then compared the data with weather records in the weeks before the people had filled out their questionnaires. ➔

SUMMER SAD: The same in reverse

Some people experience SAD not when it's dark, but when it's sunny

It's estimated that 5 to 10 per cent of people with SAD experience summer, or reverse, SAD. These individuals become depressed in the spring and summer as the days become hotter, brighter and longer. In countries near the equator, summer SAD is common compared to winter SAD, because winter SAD is rare in regions where daylight hours are consistently long all year round. People with summer SAD have a poor appetite and feel agitated – not lethargic and low, like many people with winter SAD.

"Summer SAD is a more recent phenomenon that affects relatively few people, so we still don't know much about it," says Dr Natasha Bijlani. "It's possible it's linked to a heat-stress effect."

Some psychiatrists suggest the agitation caused by summer SAD can trigger self-harm or suicide. A 2014 study published in the journal *JAMA Psychiatry* looked at death records and weather patterns across 40 years in Austria. The research found that more people committed suicide when there had been more sunshine on that day and in the previous 10 days. However, after two weeks of sunny days, suicide rates reduced. Not too much should be read into this, as multiple factors can lead to depression and suicide, but the links between light exposure and mental health are interesting.

As with winter SAD, getting a diagnosis and treatment is key to tackling the symptoms. "Reducing exposure to sunlight and keeping cool by going for a swim, using air-conditioning or having cold baths, can improve symptoms," Dr Bijlani says.



The study, published in the *Journal of Affective Disorders* in 2013, found weather patterns alone didn't predict people's mood. Other factors, such as gender differences or a family history of depression, had a more pronounced effect on people's mood than changes in the season.

"We found there were seasonal patterns in mood changes, but these were modest," Dr Kerr explains. "There's no doubt that SAD is real, it is serious and it does greatly affect people. But from our research it appears that while there is a distinct group of people with SAD, there's also a much larger group of people who have a seasonal variation in mood changes that isn't clinically significant but is still noticeable. The degree to which this affects the average person may have been overestimated. People don't always know why they are having a hard time; when people are distressed they attribute it to the weather and sometimes that's true. But sometimes it's not."

Genetics, environment, social factors and personality have all been connected to causes of depression. And research indicates that the way people think and behave could also be linked to SAD. At the University of Vermont, psychology professor Kelly Rohan is conducting a trial on 177 people with SAD, to compare the effectiveness of light therapy with a six-week course of cognitive behavioural therapy (CBT). Her early findings suggest that both treatments improved symptoms in the short term, but people who underwent CBT felt less depressed and had fewer repeat bouts of SAD two years later. CBT helps people change their thought



TOP LEFT: Vestvågøy, northern Norway, where darkness is near-total for several months during the winter

ABOVE: A polarised light micrograph of serotonin. Low levels of this neurotransmitter are linked to depression






BBC
WORLD
SERVICE

Listen to a *Health Check* programme about how seasons affect our emotions at bbc.in/OQYul2

processes, and teaches alternative ways of thinking and behaving. Prof Rohan believes it could be useful for people with SAD who have negative thinking patterns or who have behaviours that encourage them to withdraw from others during winter.

“It looks as though these results will challenge the dogma that SAD is dictated by circadian rhythm,” says Prof Rohan. “They’re consistent with a hypothesis that people’s thoughts and behaviours are also involved. So for people who don’t respond to light therapy, this may be another option.

“The study points towards the suggestions that SAD isn’t purely circadian driven or genetically mediated,” she adds. “Although they are very important factors, we need to make room for behavioural and developmental influences, too.”

The hope is that by challenging previous research to find more links to SAD, we may develop a better understanding and improved treatments to help sufferers adopt a more positive outlook. 

Lilian Anekwe is a freelance science journalist

5 TIPS TO COPE WITH SAD

If winter gets you down, there are things you can do to help make life more bearable



Get treatment

Light therapy, antidepressants called selective serotonin reuptake inhibitors and psychotherapies, such as cognitive behavioural therapy, are all recommended for helping people with SAD.



Exercise

Regular exercise, particularly outdoors, can boost your mood. It can distract you from your worries and may boost the levels of mood-improving endorphins in the brain.



Avoid stress

Get support to help you cope with stress. Avoid triggers such as tobacco, alcohol and illegal drugs – there is a strong link between cannabis use and depression.



Improve your diet

Don’t skip breakfast, eat at regular intervals and stick to slow-burning carbohydrates, such as wholemeal bread and sweet potato for sustained energy. Iron-rich foods such as red meat and green leafy vegetables can help prevent fatigue.



Stay social

Getting out and socialising can improve your mood. Keeping in touch with friends and family also means you have someone to talk to when you feel low.







STRESS-PROOF YOUR LIFE

Endless to-do list stressing you out? 9-5 making you miserable? Blood pressure rising from unpaid bills? If this all sounds familiar, it's time to take back control and learn how to chill out

WORDS: SIMON CROMPTON

Every generation thinks it's the most stressed. In the 20th Century, doctors warned that workload, education and information overload from newspapers was producing an anxiety-inducing cacophony of voices that was affecting the national well-being. Rest cures, nerve tonics, relaxation techniques and yoga were all the rage as cures for so-called 'nervous exhaustion'. Today, little has changed. But there is evidence that the World Health Organization had a point when it labelled stress "the health epidemic of the 21st Century". A long-running population study of women in Gothenburg, Sweden, found that in 1969, 36 per cent of women felt stressed, yet by 2005 the number had doubled to 75 per cent. Similarly, an analysis of self-reported data by

Carnegie Mellon University in the US found that stress levels have increased by as much as 30 per cent over three decades.

Possible reasons for soaring stress levels are constantly being proposed: too many things to engage us from too many directions; increasing expectations of our productivity; 24-hour availability; the social pressures that information technology brings.

But recent research indicates a common thread – lack of control. The 21st Century has seen a significant rise in situations where people have little autonomy but are under pressure to bring results quickly. In work, this type of stress has been found to reduce life expectancy. A 2016 study from Indiana University found that those in low control, high stress jobs have a 15 per cent

GETTY

DISCUSSION POINT

STRESS VACCINE

Should we inoculate ourselves to cope with the physical and behavioural side-effects of stress?

Scientists have long observed that physical and mental problems caused by stress have a strong association with immune system changes. This has given rise to a new wave of research, looking at whether modifying the immune system through vaccines might make us more resilient to stress.

Neuroscientists at Columbia University in the US have transferred immune cells from chronically stressed mice to unstressed mice, and found that vaccinated mice are far more resilient to stress, showing fewer depressive symptoms.

Independently, neuroscientists from the University of Colorado have modulated the immune system of mice by injecting them with a common bacterium already known to decrease anxiety. When these mice were placed in a cage with aggressive animals, they were far less intimidated than unimmunised mice, and later displayed none of the stress-related gut problems the unimmunised mice had either.

Could this mean an anti-stress vaccine is a possibility? Christopher Lowry, lead researcher at Colorado, has announced he is pushing forward with trials in humans. Ultimately, he believes the bacteria – given by pill, inhalation or injection – could help people buffer the physical and behavioural side-effects of stress. Soldiers at risk of post traumatic stress disorder are the most obvious candidates for the bacterial stress vaccine, says Lowry.

But where would this end? A pre-exam vaccine for pressurised teenagers? A jab to help us get through a tricky meeting? Ethics committees are going to be kept busy with this one.



Meditation training is a booming industry, recently valued at over \$1bn in the US. The Headspace mindfulness app alone is worth £25m

cent increase in likelihood of death, compared to those with low job demands.

And the problem is that the more we move in stressful environments, the more stressed we feel. A study by the University of British Columbia found that students taught by burned-out teachers display higher levels of stress hormones like cortisol than their fellow students who are taught by calm tutors. It seems that 21st-Century stress has all the qualities of an old-fashioned 20th-Century contagion.

So, if we are living in an age of anxiety, what's the effect on us? Doctors define stress as our body's response to mental or emotional pressure.



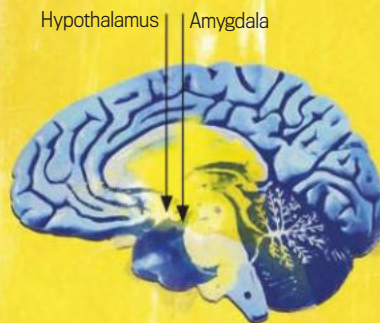
That response centres on two triangular adrenal glands sitting on top of each kidney. When we feel threatened, these release the stress hormones adrenalin and cortisol, which switch off the body's long-term repair projects in favour of short-term measures to help deal with a crisis.

They are the 'worry about the consequences later' hormones, increasing our heart rate and blood sugar levels to give us energy, but dampening down our digestion, our ability to rest and our immune response. These effects are very helpful in a short-term crisis. It helped our ancient ancestors to run fast if they were being chased by a wild animal. Yet in the modern era, where we aren't being chased by sabre-toothed cats, short bursts of stress can still be useful. A study from the University of Vienna indicated that humans are more likely to help others when under stress. The researchers scanned people's brains while they were simultaneously stressed by time tasks and asked to respond to photos involving other people's welfare and pain. The team found that the neural empathy network reacted more strongly when under stress. Short-term stress might also make us temporarily more optimistic, as experiments have shown that we pay more attention to

GETTY, DANNY ALLISON

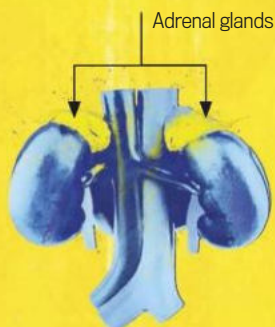
HOW THE BODY HANDLES STRESS

Confronted with a potentially difficult or threatening situation? Don't worry – your body's already gearing up to deal with it...



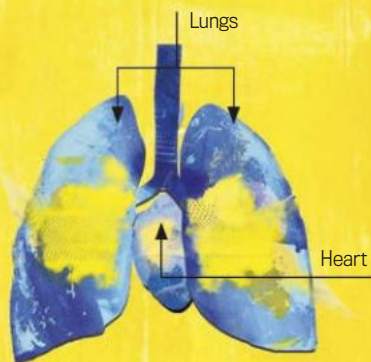
THE BRAIN

Our stress response begins in the brain. Stress or danger causes our senses to send info to the amygdala (which interprets images and sounds, and processes our response). It instantly sends a signal to the hypothalamus (the command centre), which communicates with the rest of the body through the autonomic nervous system.



ADRENAL GLANDS

The hypothalamus also activates the sympathetic nervous system by sending signals to the adrenal glands, which sit just above the kidneys. These glands respond by pumping the hormone adrenaline into the bloodstream.



HEART AND LUNGS

This brings on physiological changes. The heart beats faster than normal, pushing blood to the muscles, lungs and other vital organs. We also start to breathe more rapidly, and the small airways inside the lungs open wider, to allow the lungs to take in as much oxygen as possible with each breath.



FIGHT OR FLIGHT

The extra oxygen is sent to the brain, increasing alertness. Our sight, hearing and other senses become sharper. Meanwhile, adrenaline triggers the release of more blood sugar (glucose) and fats from the body's stores to give us more energy and nutrients. Our bodies can then deal with the problem (fight) or run away from it (flight).

STRESS MYTHS BUSTED

■ STRESS TURNS YOUR HAIR GREY

This is probably true. After all, we've seen country leaders go grey within a year of taking office. The subject hasn't been studied much, but a paper published in *Nature* in 2013 did find that hormones produced in response to stress can cause the melanocyte stem cells that determine hair colour to leave our hair follicles.

■ STRESS CAUSES STOMACH ULCERS

Nope. Common stomach ulcers are caused by an infection by *Helicobacter pylori* bacteria, not by stress. However, stress and other lifestyle factors like drinking alcohol and eating spicy food may make existing ulcers worse.

■ STRESS GIVES YOU WRINKLES

Probably true. At the end of our chromosomes is a protective cap of DNA called a telomere. Telomeres shorten as we age, and studies have shown that stress can prematurely shorten telomeres, speeding up the ageing process. One study showed that long-term anxiety caused by phobias was linked with shortened telomere length, suggesting that stress might be accelerating ageing.

■ A POST-WORK DRINK HELPS YOU DE-STRESS

Wrong again. There's evidence that people who report high levels of stress tend to drink more. In the short-term, alcohol can help you relax and take your mind off troubles. But studies indicate that regularly using booze to de-stress has the opposite effect – your body becomes immune to alcohol's effects and stress hormone levels rise.



positive information and discount the negative when we're under pressure.

But the problem is that modern stressors – from noisy neighbours to exam pressures – tend to be continuous rather than short-term. And research over the past 20 years is revealing increasing evidence of the dangers this long-term stress poses to our health.

Prof Stafford Lightman, an expert in stress-related disease at Bristol University, says that if stress hormones like cortisol are raised continuously over say 24 hours, the responses it provokes can start to cause damage. "Cortisol is an anticipatory hormone, which is normally at its highest when you wake up, but you need a holiday from it so that the body can recuperate," he says.

Chronic stress has been linked to increased blood pressure, heart attacks, reduced learning, depression, teeth grinding, obesity, hair loss, acne, lowered fertility, susceptibility to infections and some types of cancer.

"The mechanism by which chronic stress causes damage varies from tissue to tissue,"

GETTY



explains Lightman. In the brain, for example, long-term cortisol exposure reduces the links between cells in the hippocampus, the part of the brain which mediates memory. In other parts of the body it may be exposure to other substances released during the stress response – adrenaline, inflammatory cytokines, glucocorticoid steroids – that do the damage. Continual stress seems to affect the body's ability to regulate inflammation, particularly in the arteries, and this causes tissue damage and immune system disruption.

Last year, medics demonstrated for the first time that people with higher activity in the amygdala – the instinctive part of the brain that signals the release of stress hormones – are more likely to experience heart attack, angina, heart failure, stroke and arterial disease.


It's perhaps no surprise that as awareness of the risks of stress are growing, many people are increasingly obsessed with trying to stress-proof their lives. Meditation training is a booming

Research over the past 20 years is revealing increasing evidence of the dangers that long-term stress poses to our health

industry, recently valued at over \$1bn (approx £750m) in the US. The Headspace mindfulness app alone is worth £25m. Schools and employers are routinely teaching time management, prioritisation techniques, mindfulness and yoga.

Do all these stress management techniques do any good? Prof Marc Jones, a stress and emotions expert at Staffordshire University, says that there are techniques both to help you deal positively with stress in the moment, and to help you relax between demanding situations so that stress does not become chronic. Both have a role. "Different things work for different people," he says. "What we've found is that people who feel challenged rather than threatened by a demanding situation, such as a test or a public talk, respond with increased cardiac output and blood vessel dilation. These people perform substantially better than those who have a threat response, where there is little or no change in cardiac output and blood vessels constrict. The challenge response is: 'It's difficult, but I'll do it'. The threat response is: 'I'm not sure about this, I want to avoid it'. What we've found is that physiological response consistently predicts how well people do in these demanding situations."

It's possible, he says, for all of us to learn techniques to help us feel 'challenged' rather than 'threatened': "Focus on what you can achieve rather than what might go wrong."

So what are the best ways of stress-proofing your life? On the next few pages, check out our top 20 tips for dealing with stressful situations, to help you live a happier life. 

ARE YOU NATURALLY PRONE TO STRESS?

Everyone gets stressed, but some people seem more susceptible to pressures getting on top of them. But it's not just a simple matter of genetics – although scientists have found genes that do seem to affect our ability to cope when the going gets tough. What's becoming increasingly clear is that stress in childhood can affect the way genes express themselves, and these epigenetic changes seem to be linked with conditions, such as depression.

Studies in animals are showing that stress in early life makes it much more likely that stress will prompt mood problems in adulthood. Childhood stress seems to trigger biochemical changes that alter the way genes express themselves. Once they've happened, these 'epigenetic' changes can be passed down through the generations. So the stresses your parents or grandparents experienced in childhood may account for why you're easily wiped out by high-pressure situations.

Simon Crompton is a science writer who specialises in health. He tweets from @Simoncrompton2

HOW TO BEAT STRESS

20 SCIENTIFICALLY PROVEN WAYS TO HELP SLAY THE STRESS MONSTER

1 TAKE CONTROL

Research shows that mental 're-framing' can help performance if you're suffering from stress. Prof Marc Jones and his team at Staffordshire University found that the way a climbing task was verbally described to participants significantly changed how they approached the challenge – they did much better if it was made explicit that they had control of the situation. "Perceiving we have control over what might happen is a very important way for us to be able to deal with demanding situations," says Jones. "People often go into job interviews thinking they don't know what they're going to be asked, they don't know what they're going to say. Instead, think: what can I control here? Focus on very simple things you can control like how you walk into the room, how confident you appear. It's about building up our own resources to deal with stress differently."

Approach challenging situations by thinking how you can be in control



2 CALCULATE THE ODDS

Frank Ghinassi, associate professor of psychiatry at the University of Pittsburgh, recommends calculating the probability of things actually going wrong instead of 'catastrophising'. If a worst-case scenario has a one in 10 chance of happening, then it probably doesn't deserve much of your attention. So, instead, you can focus on other more important things in life.

3 REMEMBER, THINGS WILL PASS

New research carried out by psychologists from the University of London has shown that teenagers faced with stressful situations, such as exams, could reduce their stress levels effectively if they imagined themselves a year or more in the future, mentally placing themselves in a larger context and away from the immediate situation. There have been similar findings for adults as well.

4 BATHE IN THE WOODS

People who live in more natural environments tend to have lower levels of cortisol and fewer signs of chronic stress. But even if you live in the concrete jungle, just getting out and breathing in the natural world can help. Japanese research on 'shinrin-yoku' (forest bathing) has found that woodland environments lower cortisol, pulse rate and blood pressure, compared to urban spaces.

5 GET YOURSELF A DOG

Dogs are great motivators for getting some exercise. But just their company can also be a stress buster – especially for children. Children aged between seven and 12 have been found to get much less stressed about arithmetic and public speaking tasks when they have their dog with them. Having a parent present doesn't have the same effect. Another study shows owning a pet reduces blood pressure.

6 SNACK ON FRUIT AND NUTS

Snacking on some fruits and nuts on stressful days may counter stress and its damaging effects on the body. Recent tests have indicated that blueberries help counter the effects of PTSD in animals. And walnuts seem to prepare the body for stress, according to American researchers. They found that adding walnut or walnut oil to people's diet reduced blood pressure responses to stress in the laboratory.



7 PLAY VIDEO GAMES

There is evidence that playing video games can actually help reduce stress – provided it doesn't become an obsession (see page 92). Cognitive psychologists at the University of Central Florida have shown that frazzled workers benefit more from playing a simple video game during a short work break than sitting in silence or taking part in guided relaxation. This is backed by studies indicating that military veterans who regularly play computer games as a means of escape cope better with physical and psychological stressors and tend to serve longer.

8 GET MARRIED

Stress gets worse if you're lonely. Engaging with other people, particularly loved ones, buffers stress and helps you break out of a personal perspective. For years, research has indicated that married people are healthier than single, divorced or widowed people, and now there's evidence that this is directly related to lower stress levels. Testing at Carnegie Mellon University has shown that married couples have consistently lower levels of the stress hormone cortisol. But any form of engagement with others may help, as research shows that social isolation is strongly associated with raised blood pressure and higher cortisol levels.



9 HAVE A CUP OF TEA

It's the classic British response to a crisis: "Would you like a cup of tea?". And there is some evidence suggesting it provides more than a psychological boost. Research from University College London found that people who drink black tea become relaxed more quickly after a stressful task, and their cortisol levels return to normal quicker. There is still uncertainty about which tea ingredient accounts for this. But separate Portuguese research has indicated that the weak concentration of caffeine found in tea reduces anxiety symptoms in mice.

10 EAT PREBIOTICS

Prebiotics are hard-to-digest food compounds, which promote the growth of good bacteria (probiotics) in the gut. Foods particularly high in prebiotics include Jerusalem artichokes, chicory, garlic, leek, onions, asparagus, banana and whole wheat. New animal research has indicated that eating these compounds significantly prolongs REM sleep, which is believed to be essential for recovery from stress. A study of 60,000 Australians, reported in *The BMJ Open* last year, found that people who ate five to seven portions of fruit and vegetables daily had a 14 per cent lower risk of stress than those who ate zero to four.

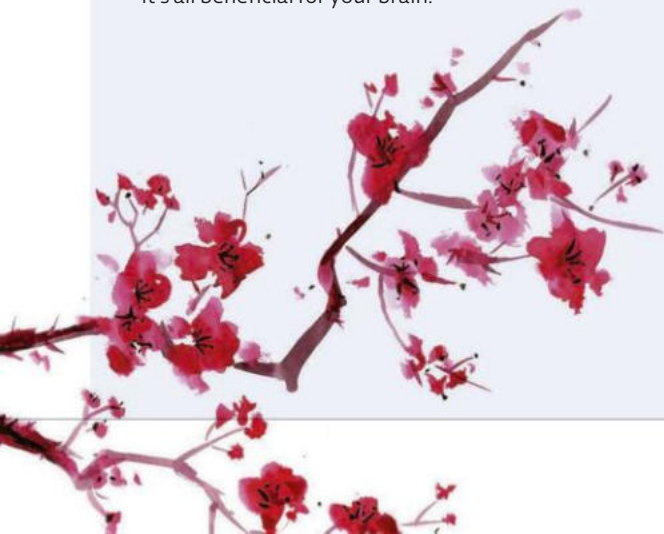
11 TAKE A HIKE

While getting out into the countryside is a great stress buster, scientists at the University of Michigan found that even looking at a picture of nature, or some trees or plants, can reduce cortisol and improve your mood. Interestingly, looking at a picture of nature was even more stress-relieving than a walk in an urban area. Google Images just became your new RX.



14 GET CREATIVE

Perhaps you approach those mindfulness colouring books with a drop of skepticism, but you can't argue with the recent findings of a San Francisco University study. The researchers found that, mindfulness aside, engaging in a creative pursuit out of work allows you to better deal with challenging times while actually improving your performance when back in the workplace. Pick up the guitar or dig out your paint brushes – it's all beneficial for your brain.



12 KEEP YOUR COOL

The Scandinavians do a lot right when it comes to health – they eat lots of fish, walk everywhere, and ski like the ice is running out. But it turns out their best trait is their collective penchant for roasting away in a sauna. Published in the journal *JAMA Internal Medicine*, one particular paper reports some interesting findings. Sauna bathing is associated with a reduced risk of cardiovascular problems and all-cause mortality, meaning that a stress-induced heart attack will be off the menu if you bake yourself regularly.

13 LAUGH IT OFF

Perhaps you're a highbrow satire fan or maybe you just appreciate seeing someone fall over on YouTube. Either way, that fit of laughter will fortify your brain against stress. In the short term, it activates your stress response, then immediately calms you down, while bringing in more beneficial oxygen. In the long run, a regular guffaw has been shown to benefit your immune system. No joke.



15 TAKE A BREATHER

If your paperwork is piling up, just pause. One of the most well-established stress busters is actually internal. Harvard scientist Herbert Benson created the idea of the Relaxation Response, and a plethora of studies have backed up his notion. Slow, rhythmic breathing calms your nervous system, allows you to deal with mounting pressure, and can help bring your to-do list back down to Earth.

16 HELP OTHERS

Despite the fact that we're focusing on looking after number one here, it pays to take others into consideration. That's according to a study published in *Clinical Psychological Science*, a journal of the Association for Psychological Science. It found that providing help to others – friends, acquaintances, or even strangers – protects your mental health against the impact of daily stress. Something as trivial as holding open a door for a colleague can keep work pressure from getting in.



17 DO THE WASHING UP

Tough day at work? It's your turn to do the dishes. Extra chores might feel like self-flagellation after an onerous 9-5 at the office, but in fact the opposite is true. Florida State University scientists did a load of extra dishes (we're sure their partners were pleased) to determine whether the contemplative and uniquely tactile moment yielded any brain benefits. It turns out that getting up to your elbows in bubbles calms the mind and reduces stress hormones. It's also likely to induce boredom and a longing for Netflix, if you ask us.

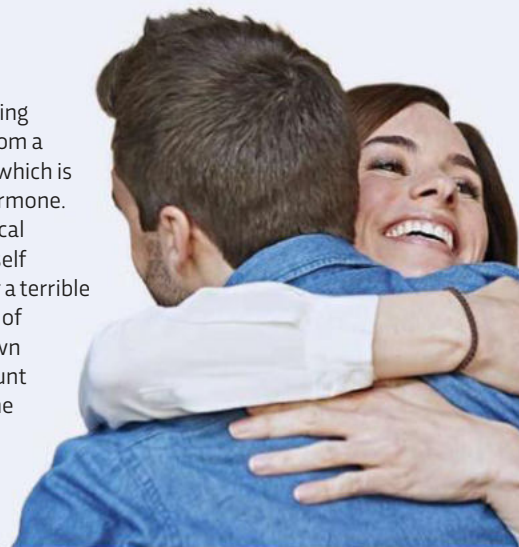


18 FIND A BRO

Depression and stress are so often uttered in the same sentence. And yet, while the former is wont to make you more insular and reclusive, the latter is actually totally different and might make you more social. A surprising study by German researchers found that stressed men in particular are more likely to seek out social bonding. Which is rather convenient, as quality bro time has been found to mitigate stress hormones.

19 GIVE A HUG

It's accepted science that getting physical with a regular hug from a loved one releases oxytocin, which is why it's known as the hug hormone. But there's another biochemical argument for wrapping yourself around your housemate after a terrible day, which comes in the form of anandamide. This one is known as the bliss molecule on account of its link to happiness, and the fact that its release feels similar to the effects of smoking cannabis.



20 ROCK OUT

Stress can be a killer, but rock music can keep you off the stairway to heaven. In a recent study into the mental effects of head bangers, scientists at the University of Queensland, Australia, discovered that, contrary to accepted wisdom, heavy metal music can help you regulate emotions, such as anger and sadness. You don't have to go full emo – a 10-minute session is all it takes to get back out of the black.





TUNE IN TO TREATMENT FM


Music moves us to tears and drives us to dance. But as well as affecting our mood, it can also have a positive impact on our health. In fact, the more we learn about the power of music, the more applications we discover for it

WORDS: PETER LOVATT AND ZOE CORMIER

Music and dance are medicinal. You might expect a statement like this to come from someone in a drumming circle, a chanting crystal healer or sleazy record-label executive. But the idea that they can be used to heal the mind is increasingly grounded in scientific evidence – not theory.

Studies have shown how people coping with Parkinson's can learn to walk more easily when rhythms assist their gait. Other research suggests autistic children find social interactions become easier when accompanied

by music, and that less anaesthetic is required when music is played to spinal surgery patients. Perhaps most astoundingly, premature babies gain weight quicker when they can hear music.

Sounds in general can cause physical reactions in powerful ways – purring cats relax us and explosions shock us – but music can do something even more extraordinary: exhilarate us. And it's only in the last 15 years that neuroscientists have been able to reveal why. For one, listening to music can stimulate ancient parts of the brain involved in reward and pleasure. But more importantly, a 



MRI and EEG scans show that playing – or even listening to – music engages almost every region of the brain

complex sequence of events result in the release of the neurotransmitter dopamine by a part of the brain called the nucleus accumbens. The nucleus accumbens releases this pleasure chemical in response to sex, drugs and music, but not to random noises. Once flushed into the bloodstream, dopamine can make us tingle from the top of our heads to the tips of our toes. What's more, music also triggers the release of other neurotransmitters such as endorphins, serotonin and vasopressin. Music is an auditory chemical cocktail – with no hangover.

So scientific studies – ranging from investigations of the brain at a cellular level, to psychiatric assessments of schizophrenics, to linguistic scores in stroke patients – are all leading to the same conclusion: music isn't just a form of entertainment, it is evolutionarily significant. And the more we learn about the impact of music on the brain, the more we understand how it is not just a mood enhancer, it can be employed as a therapeutic intervention.

SO MUCH TO LEARN

"I originally trained as a music therapist but when I went into practice 15 years ago, I found that so little formal research had been done on how or why it works," says Prof Christian Gold of the Grieg Academy Department of Music at the University of Bergen in Norway. Gold studies how music therapy can help people with a wide variety of conditions, ranging from learning disabilities to dementia to schizophrenia. "I had planned to go back into clinical practice



after spending a few years in research but, 15 years later, I'm still researching. There's just so much to learn."

Perhaps the most familiar notion of the power of music is the claim that listening to Mozart is good for your brain. But that only tells half the story. Listening to classical music (or any kind of music) does have quantifiable impacts on aspects of cognition, such as visual puzzle solving. However, everything you do – solving puzzles, playing sports, painting landscapes – has an impact on your brain.

But nothing seems to anatomically, chemically and beneficially alter your brain the way music can. The grey matter, which is the outer layer of the brain that contains the synapses – the ends of the neurones where

A music practitioner plays for a stroke patient at Florida Hospital Oceanside

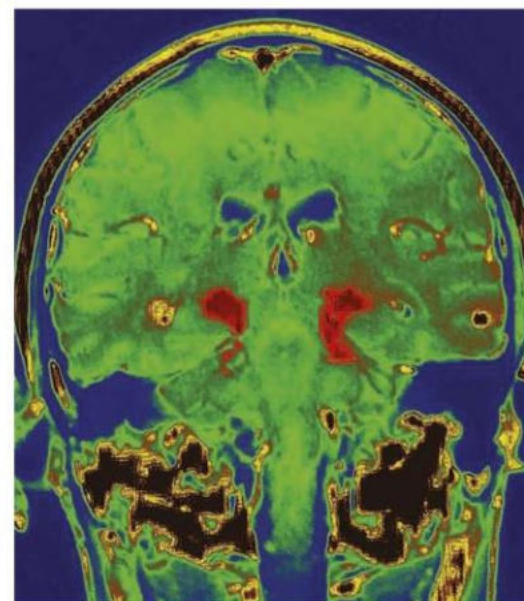


to – music engages almost every region of the brain. From top to bottom, front to back, every part of the brain is involved in the process. The newest parts of the brain, such as the frontal cortex (which is associated with higher thinking), tune in. Older structures in the middle, such as the hippocampus (crucial for memory formation) and the amygdala (central to fear and emotion), are also stimulated by the sound. Even the brainstem, the most prehistoric part, responds to music.

INDEPENDENT AGE

Humans are social creatures that require social contact. Few experiences can be more isolating than the impairments of ageing, so it's not surprising that this is one of the oldest and most established areas of research in music therapy.

Take, for example, the tremors and mobility problems that come with Parkinson's: "People with disorders that cause tremors tend to fall. Though medication can help with the tremors, there is little that can be done to help them regain the ability to walk," says Prof Simone Dalla Bella from the University of Montpellier. With metronomes and percussive instruments, he studies how melodic gait therapy can help Parkinson's sufferers walk more steadily. Similar to the way that soldiers learn to march to a drumbeat, Parkinson's sufferers can improve ➔



Parkinson's causes parts of the brain to degenerate

signals are relayed – thickens with musical training. Furthermore, the cerebellum, which is the wrinkly bulb at the back of the brain that's crucial for balance, movement and motor control, is bigger in pianists.

Neuroscientists have documented many other anatomical changes that come with musical experience but the most profound is thought to be the fact that the corpus callosum – a band of nerve fibres that connect the left and right hemispheres to each other – thickens. No-one is quite sure what helping the two sides of the brain to communicate with each other accomplishes, but 20 years after this discovery, nobody has found anything else that does this.

What's more, MRI scans and EEG recordings show that playing – or even just listening



DANCING FOR JOY

Why getting our groove on makes us so happy

Whether you get drunk on disco, made merry by merengue or euphoric from pulling some moves in a hot, sweaty nightclub, dancing is renowned as a fantastic mood enhancer. And it seems that everyone can experience that euphoria – a study in 2010 by Marcel Zentner and Tuomas Eerola found that babies smiled as they moved to music. The more they moved, the more they smiled.

So why does dancing make us feel better? It might be because as we move together in response to music, we also move in response to each other's rhythms, helping us to form a social bond. It's one of the reasons why we love music festivals. A 2010 study by Sebastian Kirschner and Michael Tomasello at the Max Planck Institute for Evolutionary Anthropology showed that after a session of paired music making, four-year-old children were more likely to behave cooperatively and helpfully. So music and dancing act as a kind of social lubricant, helping us to bond and form positive relationships. That could explain 'flash mobs' – when a group of people suddenly assemble in a public place, perform an unusual routine, and then quickly disperse.

Not only does dance help us bond with others but, as with any intense physical activity, it can also release endorphins – the feel-good, pain-relieving brain chemicals responsible for the so-called 'runner's high'. In fact, Bronwyn Tarr and colleagues at the University of Oxford found that just dancing in time with someone might be enough to release these neurohormones into the bloodstream. They asked Brazilian high school students to dance in groups of three to fast-paced music, finding that those who synchronised their movements had an increased pain threshold (as measured by inflating a blood pressure cuff around their arm). This suggests that there were more endorphins in these dancers' bodies, so the researchers speculate that we might get a social 'high' from dancing with others.

Dance has also been found to boost self-esteem. In a 2007 study, researchers from Laban and Hampshire Dance found that children aged between 11 and 14 who took part in creative movement classes reported improved self-esteem and motivation.

All these studies show that dance is one of the most important activities we can do. It's good for health and makes us happy. So why not throw caution to the wind and bust some moves.



As with any intense physical activity, dancing can also release endorphins – the feel-good, pain-relieving brain chemicals responsible for the so-called 'runner's high'

their walking with the help of a rhythm.

"The fascinating thing about this therapy is that the benefits are not confined to gait – we also see improvements in things like motor control," says Dalla Bella. "Patients who are given auditory cue training, for example, can greatly improve in their perception of and ability to produce speech."

The mechanism by which music helps Parkinson's patients appears to lie in the nucleus accumbens – the brain region that releases the pleasure neurotransmitter dopamine in response to stimulants like drugs or sex. Parkinson's is characterised by an impairment of the connections between a cluster of brain structures called the basal ganglia and other regions due to a lack of dopamine. So it makes sense, says Dalla Bella, that if music can trigger the release of dopamine in that region, it would be helpful.

MUSICAL MEMORIES

Music is also helping Alzheimer's sufferers. More than 25 million people in the UK are affected by the condition, through knowing somebody who has dementia.

"We don't have a cure for Alzheimer's and there is no cure on the horizon: we need to work on ways to make the sufferers' lives, and the lives of their carers, easier," says Dr Victoria



Lost Chord's founder Helena Muller helps dementia patients to enjoy live music

Williamson, a psychologist at the University of Sheffield, author of *You Are The Music*. "Music is not a pill or a vitamin or a cure, but it can provide powerful support, alleviating real symptoms like depression and anxiety. There is no reason not to invest in providing music to as many people living in care homes as possible."

After spending many years in the lab studying musical memory, Williamson began working with the charity Lost Chord. The charity was set up in 1999 by Helena Muller to provide live music in residential care homes for people with dementia.

Marion Jones, whose husband has severe Alzheimer's, says: "The choir at the Lost Chord memory cafe is one of the few things that makes him smile."

Indeed, the Alzheimer's Society says the live music events are lifelines: "People can revert back to being a couple again rather than carer and person with dementia. The benefits gained


by people with dementia are immeasurable. To observe people who are withdrawn and isolated come out of their shell and engage by singing and dancing is tangible, powerful and emotional for all to see."

THE BEST INVENTION

Indeed, the deep hold that music can have in our memories is perhaps best exemplified at events like the Lost Chord memory cafes. Even when people with advanced-stage dementia can't remember the names of their children, they can recall lyrics from the songs of their childhood.

This brings us back to what music, ultimately, is – a form of social navigation via sound. As it involves so many ancient brain regions, and can be used in so many therapeutic ways,

is music something we are 'hardwired' for?

"I used to think so – but the more I learn about music, the more I think it's not something we inherited: I think it is an invention. Yes, our brains are pre-programmed to be able to produce music. But music didn't make us – we made it," says Williamson. "We began making music because it fulfilled so many useful purposes: communication, social bonding, teamwork, sexual attraction. It's a ball we just can't put down. This is the best invention we ever came up with." 

Dr Peter Lovatt is a dance psychologist who runs the Dance Psychology Lab at the University of Hertfordshire

Zoe Cormier is a freelance science writer and author of *Sex, Drugs & Rock 'N' Roll: The Science Of Hedonism*



Listen to Prof Robert Winston on the science of music <http://bbc.in/2CFZr7n>



HOW TO

HYGGE YOUR HOME

Five top tips for creating a cosy sanctuary

1 In 2016, the buzzword on the lips of every advertising agent, lifestyle magazine editor and blogger was 'hygge'. Pronounced 'hooga', the Danish word epitomises a vibe of 'calm cosiness'. Here, Meik Wiking, CEO of the Happiness Research Institute, suggests five ways to bring a little hygge into your home...

1 Make a hygge-krog

Every home needs a hygge-krog, which roughly translates as 'a nook'. It is the place where you love to snuggle up with a book and a hot drink.

2 Bring in nature

Danes feel the need to bring the entire forest inside. Any piece of nature you find is likely to get the green light. Leaves, flowers, pine cones... basically, think how a Viking squirrel would furnish a room.

3 Think tactile

A hyggelig interior is not just about how things look, it is just as much about how things feel. Letting your fingers run across a warm, wooden table is a different feeling from being in contact with something made from cold steel or plastic.

4 Light candles

As soon as it gets dark, Danes tend to light candles, especially in the winter. Candles instantly create a cosy mood and offer a softer light than overhead bulbs.

5 Linger longer

Danes love to linger, particularly after a good meal. While many people around the world start to clear up as soon as a dinner party is finished, Danes just relax – giving time for mindfulness.

“Danes feel the need to bring the entire forest inside... think how a Viking squirrel would furnish a room”





Kirk Rutter's severe depression improved after he took psilocybin

PSYCHEDELIC HEALING

At any given moment, more than 3 per cent of the UK population are thought to be suffering from depression.

For some people, like Kirk Rutter, symptoms persist despite treatment. Could psilocybin – the psychedelic drug found in magic mushrooms – help to put an end to depression by ‘rebooting’ the brain?

WORDS: KAT ARNEY

WARNING

Psilocybin and hallucinogenic mushrooms are a Class A drug according to UK law. Anyone caught in possession of such substances will face up to seven years in prison, an unlimited fine, or both. More information and support for those affected by substance abuse problems can be found at bit.ly/drug_support

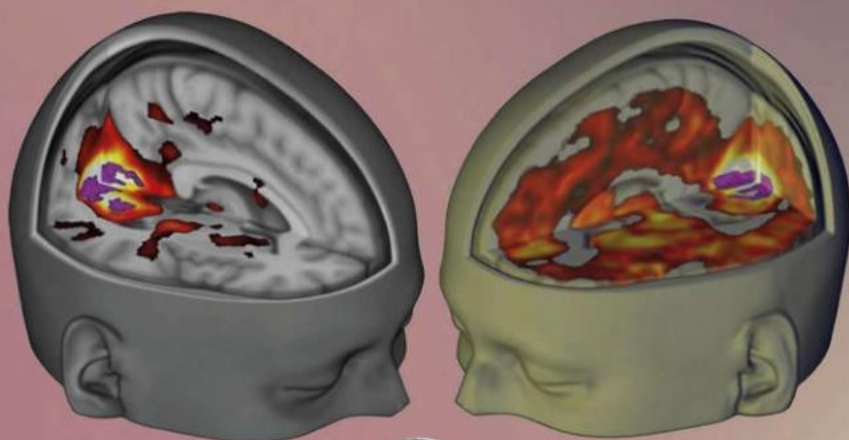
Kirk never got over the death of his mother. When she passed away in 2011 after a long illness, the 47-year-old IT specialist kept himself busy by organising her funeral and dealing with the other administrative tasks that come with a death in the family. But while his father and brother managed to pick themselves up and move on, he struggled to come to terms with the loss.

"After the funeral was over there was nothing left to organise or create, and I found myself in a kind of void that just persisted until I was overwhelmed," he says. "After six months I was still talking about her death, and I wondered whether I should be over it by now. Should I have moved on? Should I be better? But I kept feeling worse and worse until I was just chronically sad all the time."

Eventually, Kirk spiralled into a deep depression that pervaded all areas of his life. He signed up for counselling and visited a therapist every week for a year. It didn't work. His GP prescribed different antidepressants, but they didn't work either. "The drugs just turned me into a zombie," he says. "And although I talked through everything else in my life during counselling, I just couldn't talk about the grief."

Every year, thousands of people in the UK are diagnosed with depression and these numbers keep rising. While antidepressants are a common treatment, studies suggest that more than half of all patients don't respond to the first drug they're given. A significant proportion of people with depression fail to find something that works for them, ending up cycling through periods of treatment and relapse.

In search of a more effective approach, researchers at Imperial College London have been finding out whether the mind- and mood-altering properties of psychedelic drugs, such





ABOVE: Dr Robin Carhart-Harris, who is carrying out the psilocybin research

LEFT: These MRI scans show a 'normal' brain (left) and a brain under the influence of LSD (right). It is thought that psilocybin may affect the brain in a similar way to LSD – both hallucinogens have been trialled to treat depression

BELOW LEFT: Various magic mushrooms are found throughout the world

BELOW: The volunteers took the drug in a relaxing room to reduce the risk of a bad trip



as psilocybin (the active ingredient in magic mushrooms) could be helpful for treating psychiatric conditions. Led by Dr Robin Carhart-Harris, a team of researchers have been running a clinical trial testing the effects of psilocybin on a small group of people with intractable depression. People just like Kirk.

THE PSYCHEDELIC SPA

“We’d been doing brain imaging studies looking at the effects of psilocybin which suggested that it might have antidepressant effects,” explains Carhart-Harris. “We also knew that psychedelic drugs can dissolve the ego [the sense of ‘self’] temporarily. This is accompanied by the possibility of emotional, personal, philosophical and existential insight, so it was a case of joining the dots.”

Spurred on by a previous study showing that people who took psilocybin reported a long-term increase in psychological wellbeing and a trial showing the drug’s benefits for treating anxiety and depression in terminal cancer patients, Carhart-Harris created a plan to test if it could relieve treatment-resistant depression.

Despite receiving some funding from the Medical Research Council in 2012, the proposal was hampered by ethical and regulatory red tape, as well as the challenge of obtaining clinical-grade psilocybin. But after three frustrating years Carhart-Harris was finally able to start recruiting patients for his unconventional clinical trial, and Kirk was one of them.

“I was open to something potentially a bit more healing than just trying to gloss over the feelings or chemically dull them,” Kirk says. After an initial interview over the phone, he was invited to come to Imperial College’s clinical research facility in London for a longer discussion and a lengthy questionnaire. Next was an orientation session, allowing Kirk to

get used to the environment in which the drug would be administered. He was taught a grounding technique to combat anxiety and stay anchored in reality. Then came a blindfold and headphones playing a specially curated music selection ranging from ambient sounds and tribal rhythms to soaring opera, interspersed with short periods of silence.

“I went into this hospital room and it was done up like a psychedelic spa!” he laughs. “There were

imitation candles, throws, aromatherapy machines – it was very relaxing. So, when it came to actually taking the first dose of psilocybin I felt reassured because I’d seen the room and heard the music, I’d been in that space and thought it was a nice environment.”

TRIPPING ON TRIAL

The researchers tested 19 volunteers with two doses of psilocybin – 10mg and 25mg – given a week apart, each with an MRI scan before and afterwards.

While the first dose is relatively low so the participants get used to the sensation, the second one packs a bigger psychedelic punch.

“It’s a big trip, and it’s probably more than people would take recreationally,” explains Carhart-Harris. “That’s the kind of dose required to produce ego dissolution, the sense of oneness that has been said to be at the core of what some people describe as a mystical experience on psychedelics. It’s a massive trip, but they’re doing it in a controlled way in a clinical research facility with psychiatrists, beautiful music, low lighting, nice furnishings, and an emergency medical response team on hand in case anything goes wrong.”

For Kirk, this higher dose produced a profound effect. “After taking the higher dose I started seeing this weird Sanskrit writing, then it got a lot busier and more psychedelic,” he says. “The music played a big part of the experience – it’s like a river guiding you through a landscape. I remember an operatic piece that felt like I ➔

“I was open to something potentially a bit more healing than just trying to gloss over the feelings or chemically dull them”

THE SCIENCE OF PSYCHEDELICS

At a molecular level, psilocybin works on the serotonin system in the brain. Serotonin is a neurotransmitter that sends signals between neighbouring nerve cells. It's often described as the 'happy chemical', but in fact there is a complex and poorly understood relationship between serotonin and mood.

Psilocybin sticks to the serotonin 2A receptor – 1 of 14 different types of serotonin receptor found on nerve cells – and appears to induce a state known as 'plasticity', where systems and pathways in the brain can be reset. A principal system affected by psilocybin is the default mode network, which is involved in higher-level conscious functions including our sense of self (ego) and the story we construct

about our identity and place in the world.

Depression is characterised by entrenched, intrusive thought patterns, reflected by abnormal activity in the default mode network. Under the influence of psilocybin, this network seems to temporarily dissolve and break down, leading to a loss of self-identity and a strong sense of inter-connectedness with the rest of the world. It literally opens the mind.

By breaking down these embedded systems and allowing them to reform in a new way, psilocybin can help to 'reset' the brain. This could provide a way for people to break free from their depression and move towards healthier thought patterns.

was being lifted up and it was all washing over me, then it guided me to a sad place where all the grief came up. At one point my eyeshade was so wet I had to wring it out because I'd let go of so much sadness."

This intense emotional release enabled Kirk to finally address the feelings he had buried since the death of his mother.

"Right afterwards I felt very relaxed and spaced out, and I had a really good sleep that night," he says. "There was a lot of processing that happened, coming to terms with the grief. There will always be that sense of loss, but I'm not crushed by it like I was before and I've become much less withdrawn at work and socially. A week after the treatment I was out shopping with a friend and I just had this sensation of space around me. I realised it was a feeling of optimism that I hadn't had for so long, and it felt really good."

"At one point my eyeshade was so wet I had to wring it out because I'd let go of so much sadness"

The results of the trial were impressive. Psilocybin caused no significant side effects other than mild nausea and headaches in some people, and didn't lead to any unpleasant flashbacks. More importantly, it seemed to work. All the participants had a reduction in their depression symptoms, with those who had the most extreme psychedelic experiences having the greatest improvement – an effect that has persisted in the long term. Two years after taking part in the study, Kirk is still feeling well and hasn't returned to taking antidepressants.

Carhart-Harris also saw a difference in the brain scans of volunteers after they'd undergone the treatment. He noticed that certain networks in the brain seemed to break down under the influence of psilocybin and reformed again afterwards, particularly the default mode network – a system in the brain that is associated with our internal world and sense



of self (see box, left). He also saw a boost in responsiveness in a region of the brain called the amygdala, which is associated with emotions – the opposite of the emotional flattening that many people experience when taking conventional antidepressants.

“The default mode network is over-engaged in people with depression and it’s hard to turn it off, so they get stuck in a rut in their own head. When people are in the throes of an intense psychedelic experience the default mode network will be quite markedly disintegrated,” he says, pointing out that the people who showed the most clear reformation of the default mode network after taking the drug were those who improved most after treatment.

“With psilocybin, you take a system that is somehow functioning abnormally, then scramble it, melt it, shake it up and then you let it reformat, and maybe it resets in a way that is somehow healthier. There is a loss of sense of self and identity, but what replaces it is a sense of being connected to nature and other people and the Universe,” says Carhart-Harris.

DON'T TRY THIS AT HOME

Although the results from the trial are promising, Carhart-Harris cautions against trying psychedelics without medical supervision. For a start, psilocybin and magic mushrooms are Class A drugs in the UK and carry heavy penalties for possession or supply. There are also significant psychological risks.

“Psychedelics induce a state of sensitivity and vulnerability,” he explains. “People are in a state of special psychological plasticity just like children are, and they’re sensitive to context and emotion more than they ordinarily would be. It’s important that they are nurtured and protected – if the conditions aren’t right then the experience can be bad and you can potentially harm people.”

Carhart-Harris is planning a new trial which is due to start recruiting up to 50 patients in early 2018, comparing a single dose of psilocybin with a six-week course of the ‘gold standard’ antidepressant drug escitalopram. He also thinks that psilocybin therapy could be beneficial for many other psychological conditions involving embedded or repetitive thought



In the 1960s, while a faculty member at Harvard, Dr Timothy Leary carried out psilocybin studies on volunteers. However, his studies had a lack of scientific rigour and did not follow correct research protocol. He was fired from the university and thrown out of academia, but became a figurehead for the counterculture and drug movement

processes, including anxiety, eating disorders, OCD, chronic pain and post-traumatic stress disorder (PTSD). And he’s keen to explore whether it could help prevent people in the early stages of depression from sliding into the kind of deep despair that Kirk experienced.

“Prescriptions of antidepressants are going up year-on-year but a lot of people don’t want to take them – often for valid reasons – so we shouldn’t prevent them from having access to psilocybin treatment,” he says.

Yet despite the potential of the drug, funders and policymakers remain wary of it, much of which stems from unchecked or unethical research practices dating back decades. Due to the difficulties in gaining funding for his work, Carhart-Harris’s research is currently supported by private donations. A UK-based start-up company, Compass Pathways, is also seeking funding to carry out a larger-scale clinical trial of psilocybin across Europe. But although he’s excited about the potential for psychedelic drugs, Carhart-Harris also knows that the underlying research base needs to be solid, and a lot more work remains to be done. **P**

Dr Kat Arney co-presents BBC 5 live *Science*. Her latest book is *How To Code A Human*.



Watch a clip from *The Brain: A Secret History* in which BBC presenter Dr Michael Mosley takes a dose of psilocybin at bit.ly/psilocybin_brain



CHANGE YOUR MIND

Research shows that a particular form of
meditation can make us happier and less anxious
by altering the structure of our brains

WORDS: MICHAEL MOSLEY EXTRA WORDS: ANDY RIDGWAY



Dr Michael Mosley has electrical activity in his brain measured while practising mindfulness meditation

Ever find yourself going for a long drive and reaching the end without being aware that you were driving, lost as you are in your own musings?

Or do you find yourself

wide awake at 3am, largely unhelpful thoughts rattling around inside your head, each thought competing for your attention to the point where you have to get up and do something boring to drown them out? If so, then you are not alone. Studies suggest that many of us spend up to half of our waking lives wrapped up in our own internal world. We over-think – and like overdoing anything, over-thinking tends to have negative consequences. It can lead to a negative spiral of indecisiveness, self-loathing, depression and insomnia.

But a growing number of us are trying to overcome these problems using mindfulness meditation. I had been intending to try it for some time, but never quite got round to it. But during filming a while back for a BBC *Horizon* programme *The Truth About Personality*, I finally got the chance to give it a go.

Inherited from Buddhism, mindfulness meditation has been gaining popularity in the West since the 1970s. There are as many definitions of mindfulness as there are practitioners, but at its core it involves paying attention to the present moment in a non-judgmental way.

There have been many claims about the technique's abilities, but until recently relatively little convincing proof. But now more rigorous studies and new technology, which allows us to see what's happening inside the brain like never before, have given it scientific credibility.

Before throwing time and effort into

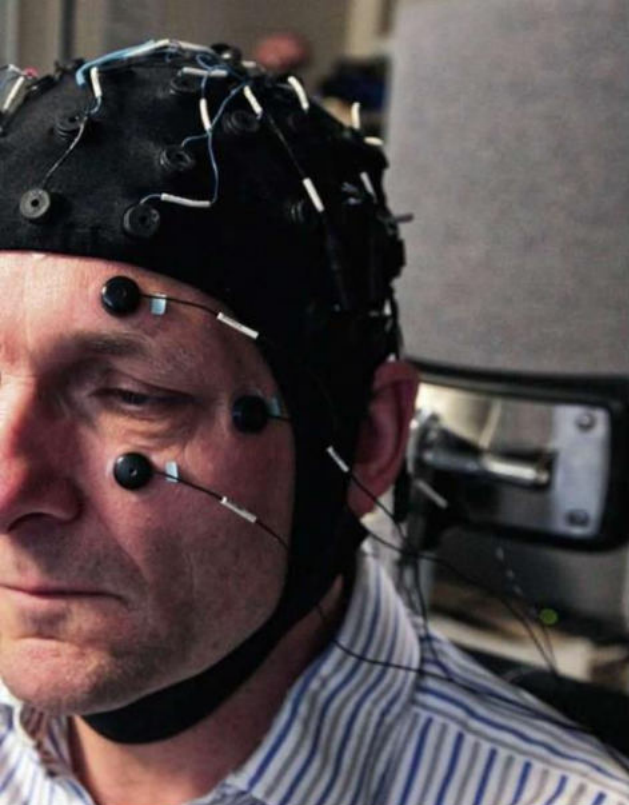


There was increased density of the hippocampi grey matter, the area important for learning and memory

mindfulness, I wanted to find out what science had to say about it. It turns out that there are convincing pieces of evidence that mindfulness meditation does actually work.

Back in 2011, a research team based at Massachusetts General Hospital (MGH) reported the results of a study in the journal *Psychiatry Research: Neuroimaging*. The team gave a group of 16 mindfulness novices a brief training programme. These volunteers spent around half an hour a day doing mindfulness exercises.

They reported improvements in their mood and stress levels, but it's what was going on inside their heads that was more impressive. When the researchers looked at 'before and after' magnetic resonance imaging (MRI) brain scans, they were surprised to see an increased density of the grey matter in the volunteers' hippocampi, the area of the brain important for learning and memory. The researchers also saw decreased grey matter density in the amygdala, a part of the brain that is implicated in feelings of anxiety



and stress. What's particularly impressive is that all these changes were recorded after just eight weeks. "Previous studies had compared long-term mindfulness practitioners to non-meditators and found differences," says Dr Sara Lazar, who led the research at MGH. "But these differences may be due to something other than meditation. For instance, meditators tend to be vegetarian and live healthy lifestyles. This study was the first to take people who had never practised meditation before and compare them to a control group [a group that did not take part in any meditation]. So the changes are highly likely to be due to meditation practice."

In short, in just two months, mindfulness meditation appears to change the brain.

Now based at Harvard University, Lazar recently carried out a study on older ladies, comparing 21 women who had practised hatha yoga for at least eight years and a control group of 21 women who had never tried it. The cortex in specific regions of the brain was thicker in the yoga practitioners than the control group.

What's not completely clear is exactly how these increases in grey matter density manifest themselves – whether it's down to neurones appearing or disappearing, or connections between the nerve cells being made or lost.

"There could also be changes in the helper cells that surround the nerve cells or the blood vessels," says Lazar. "All have been associated ➔

IN A NUTSHELL

What mindfulness meditation is – and what it isn't

The idea of meditation comes with a lot of misconceptions. Some believe it demands religious faith. Others think it requires hours of sitting in the lotus position while banishing all thought. In reality, mindfulness meditation simply involves becoming aware of one's thoughts, feelings, and surroundings without judgement. It can be done anywhere, anytime, though beginners are advised to start practising in a place where they can sit quietly for a few minutes without distraction.

The idea is then to become aware – mindful – of some aspect of the present, such as one's own breathing, and focus one's thoughts on that.

This may sound simple, but even experienced practitioners often find that their minds wander. The intrusive thoughts can be anything from

memories of past arguments to feelings of cosmic bliss. But the key is to note that the thought has arisen and then return to focusing on the breath.

The classic beginner's mistake is to feel bad about having intrusive thoughts or become lost in them. "The brain will always produce thoughts," says Harvard psychologist and mindfulness expert Dr Chris Germer, author of *The Mindful Path to Self-Compassion*. "Mindfulness allows us to develop a more harmonious relationship with our thoughts."

Starting with short sessions of five minutes, sessions can be built up to 30 minutes or more. However it's done, practitioners typically become increasingly aware of the vagaries of the mind, and how accepting 'bad' thoughts helps rob them of their power.





with changes in behaviour and learning, but the resolution of the MRI scans is unable to reveal this."

IMPROVING MEMORY

Mindfulness has also been found to have an effect on working memory. The most powerful demonstration of this came from a group of US Marines being prepared for deployment to Iraq. During pre-deployment training, where the Marines are put through incredibly stressful

Richard Davidson of the University of Wisconsin (third from left) has been scanning the brains of meditating monks

situations to 'inoculate' them against the horrors of war, 31 were given eight weeks of mindfulness training. Another 17, the control group, were not. The researchers at the University of Pennsylvania and Georgetown University in the US found that during this stressful training period, working memory capacity fell in the control group but increased in those who had meditated.

"Since pre-deployment training is stress inoculation training in the extreme, we had expected everyone's working memory to decline," says Dr Elizabeth Stanley, who served as a US Army military intelligence officer in Korea and Bosnia before becoming an associate professor at Georgetown. "We were surprised to see that mindfulness actually improved working memory among the high practice group [those who practised on average 15 minutes a day over the eight weeks outside of class]."

The same techniques have been tried with firefighters and police officers – to great success. So mindfulness training may well become part of our working lives in the future.

UNIVERSITY OF WISCONSIN

INSIDE THE MEDITATING MIND

Brain scans of meditating Buddhist monks reveal the profound effect that mindfulness can have

To study what happens in the brain during meditation, Zoran Josipovic, a research associate at the New York University (NYU) Cognitive Neurophysiology Lab got Tibetan Buddhist monks from monasteries around the city to have their brains scanned while meditating.

But this proved to be a challenge, as a functional magnetic resonance imaging (fMRI) machine is fairly noisy and hardly a calm, natural environment in which to meditate.

"The noise is around 110dB and you have to lie down in a very confined space with your head immobilised," says Josipovic.

The volunteers were asked to undertake 'focused attention' meditation, while using a mask and headphones to block out the loud whirring of the fMRI machine that measured the blood flow – and therefore activity – across the brain.

The results showed increased activity in the areas of the brain involved with performing tasks and processing information from the environment. Interestingly, they showed less activity in brain areas that are usually active when people are thinking about themselves.



While all these studies have looked at what happens to the brain after meditation programmes, few have looked at what's going on during meditation. But Zoran Josipovic, research associate at the New York University (NYU) Cognitive Neurophysiology Lab, did just that. He enlisted the help of some volunteers adept at meditation – Tibetan Buddhist monks from monasteries around New York (see below).

“We saw increased activity in the brain’s extrinsic system – areas involved with performing tasks and processing information from the environment,” says Josipovic, who practises Buddhist meditation himself. “There’s also a reduction in activity in areas usually active when people reflect on matters that involve themselves.”

SELF-EXPERIMENTATION

I found all this convincing enough to try a six-week course of mindfulness meditation via an app.

You sit in a comfortable chair, rest your hands on your thighs, close your eyes and then for the

“We were surprised to see that mindfulness actually improved working memory”


Dr Elizabeth Stanley, Georgetown University

next few minutes try and focus on your breath. You pay attention to the sensation of the breath going through your nostrils, filling your chest, expanding and contracting your diaphragm. You try to stay focused on the task and when you notice that your thoughts have drifted, which they will, gently bring them back to the breath. You have to treat thoughts like balloons that drift into your consciousness; once you have noticed they are there you simply allow them to drift away.

I say ‘simply’, but this is really hard to do. Initially I found that I spent much of the allotted time (10 minutes a day at first, building up to 20) absorbed in my usual concerns. But like any form of exercise it slowly got easier to do, though I rarely managed more than a few minutes of focus at a time.

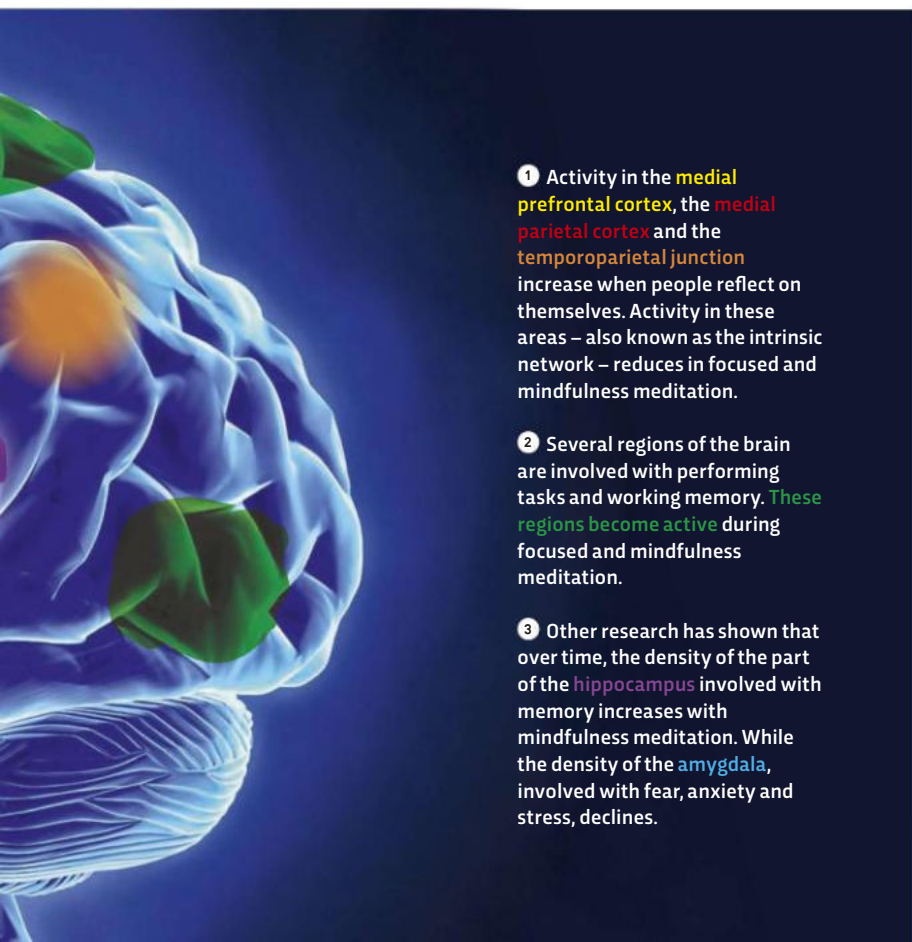
As well as sitting quietly, I also tried building mindful moments into my day. Instead of just gulping down a coffee, I’d hold it and feel the warmth and try to focus on the muscle activity involved in bringing it to my lips. I’d feel the warm liquid trickle down my throat.

At the end of six weeks I felt noticeably calmer in my everyday life. Not only that, but also more able to focus on tasks – particularly the more complex ones.

So if you like the idea of being happier, less stressed and keeping your working memory active, why not give mindfulness a go? I certainly found it helpful – and I plan to go on making it part of my daily life. 

Dr Michael Moseley is a presenter on *Trust Me, I’m A Doctor*

Andy Ridgway is a science writer and Senior Lecturer in Science Communication at the University of the West of England



① Activity in the **medial prefrontal cortex**, the **medial parietal cortex** and the **temporoparietal junction** increase when people reflect on themselves. Activity in these areas – also known as the intrinsic network – reduces in focused and mindfulness meditation.

② Several regions of the brain are involved with performing tasks and working memory. **These regions become active** during focused and mindfulness meditation.

③ Other research has shown that over time, the density of the part of the **hippocampus** involved with memory increases with mindfulness meditation. While the density of the **amygdala**, involved with fear, anxiety and stress, declines.




THE

Fewer murders and reduced suicide rates, new research is suggesting that adding lithium to our water could make us all a lot happier

WORDS: JO CARLOWE

RAPY ON TAP



Imagine a future in which our health, behaviour and mood are determined by chemicals in our water. It might sound like something out of Aldous Huxley's dystopian novel *Brave New World*, but the idea may not be so far off – scientists are investigating whether lithium in the water supply might have an 'anti-suicide effect'.

The research stems from the fact that lithium is a known mood stabiliser. Indeed, it is used in psychiatry to treat bipolar disorder. Since its therapeutic properties were discovered in 1949, it's been credited with halving the suicide risk in patients with mental health problems. But the argument now is that all of us might benefit from imbibing more lithium.

While the workings of lithium are not fully understood, most experts believe it strengthens nerve cell connections in the areas of the brain associated with mood regulation and behaviour. As a result, it reduces the symptoms of mania, impulsive behaviour and depression. Some scientists go further, and claim it also heals nerve damage and protects against the onset of dementia. So now experts are trying to ➔

GETTY

Higher levels of lithium in the water were associated with lower suicide rates

test whether daily exposure to small amounts of environmental lithium might be of health benefit not just to those already suffering from depression, but to the population in general. Most of us are already exposed to some lithium, as it occurs naturally in tap water. But even in areas with high environmental levels this only translates to around 2mg a day, while therapeutic doses typically start at 300mg daily.

A recent study in Lithuania found a link between lithium levels in drinking water and suicide rates. Samples from public drinking water systems were taken in nine cities across the country, and compared with data on suicide numbers. The research team found that higher levels of lithium in the water were associated with lower suicide rates in men (but, interestingly, not in women).

Previous studies in Japan, Austria and the US had also found a correlation. In 1989 a paper was published in the US called *Lithium in Drinking Water and the Incidences of Crimes, Suicides, and Arrests Related to Drug Addiction*. The researchers examined the lithium level in the water of 27 counties in Texas. Incredibly, the area with the highest lithium level had nearly 40 per cent fewer suicides than the area with the lowest lithium level. Moreover, the counties with the highest levels of lithium in their water also had a statistically significant decrease in the incidence of homicides and rapes.

In 2009, a study in Japan found that increased amounts of trace lithium in the water supply correlated with decreased suicide rates. Similar results were replicated in 2011 in Austria. The researchers took a nationwide sample of 6,460 lithium measurements and examined these for association with suicide rates across all 99 Austrian districts. The results again showed an inverse association – the greater the amount of

RIGHT: The soft drink 7 Up used to contain lithium

BELOW: In future, might our drinking water be infused with lithium to help us be happier?





TOP: What water there is in the Atacama Desert has a very high lithium content

ABOVE: Fluoridated water can help prevent tooth decay

lithium in a district's water, the fewer suicides. This remained significant even once the data had been adjusted for socioeconomic factors. The researchers concluded that as much as 4 to 15 per cent of the country's geographic variation in suicide rates could be attributed to varying levels of lithium in regional water supplies.

SPAS AND SOFT DRINKS

In view of all these results, some have argued that this trace element should be actively added to tap water to help keep us stable. But the idea of governments doctoring the water remains controversial. Indeed, Professor Allan Young from the Institute of Psychiatry in London, received death threats when studying the impact of environmental lithium on our well-being. This was despite the fact that there is nothing new about adding chemicals to drinking water.

Water fluoridation to prevent tooth decay dates back to the 1940s. Today the majority of US citizens drink water with added fluoride, but in the UK only 10 per cent of us receive fluoridated water. Public Health England recently published a report showing that 28 per cent fewer five-year-olds and 21 per

cent fewer 12-year-olds have tooth decay in these areas.


The notion that lithium in water might be healing has an even longer provenance than fluoride. Between 1785 and 1949, the lithium-rich waters of the Pitkeathly Wells spas in Scotland were popular for health and 'nervous problems', while the Lithia Springs in Georgia in the US were visited by Mark Twain and Theodore Roosevelt for their curative powers.

'Lithia water', high in lithium salts, was also added to many popular drinks, purportedly for its health benefits. One such drink was Bib-Label Lithiated Lemon-Lime Soda – an early name for 7 Up (lithium presumably providing 'the up', the '7' possibly representing its atomic mass). In the 1940s, changes in the regulation of the drinks industry, and concerns about lithium's toxicity, saw it removed from commercial beverages. Thereafter, following the discovery of its psychotropic benefits, it largely remained the preserve of the psychiatric community.

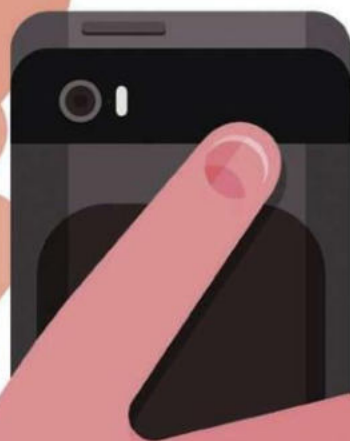
THE NEXT STEP

Perhaps the results of the Lithuanian study will kick start new debate on whether lithium should be added to our drinking water, just like fluoride in the US. There is currently not a single place in the world where it is added to the water supply for the benefit of public health.

Professor Young says there are "many scientific hurdles" to cross before such an idea could come to fruition. "But we should be doing the science," he says. "There need to be more environmental studies about the impact of higher environmental lithium. If you couldn't put lithium in the drinking water you could give people much lower doses and study them over a prolonged period of time. It is rather perplexing to me that there isn't a big research effort going on in this area."

The chances of lithia water becoming as commonplace as it was 50 years ago currently seem slim. But with one million people dying annually from suicide, the argument for at least doing the research is persuasive. 

Jo Carlowe is a science journalist who writes for *The Times* and *The BMJ*



TIME FOR A TECH DETOX

Many of us are hooked on our smartphones. But for a growing number of people it's getting so bad that they are entering rehab for technology addiction. So what could these extreme cases tell us about our relationships with gadgets?

WORDS: EMMA YOUNG

Can't put your phone down? You're not alone. A 2016 survey found that the average person spends 145 minutes a day on their phone – that's over 36 days a year. But for some, it's more than just a bad habit. Mental health hospitals that traditionally treated alcoholics and drug addicts are now treating tech addicts, too.

One such hospital is the Nightingale Hospital in London. Dr Richard Graham is head of its Technology Addiction Service, and the stories of his past and present patients* may sound familiar. Ryan is a teenager who spends eight to 10 hours on screens after school, mostly on YouTube. Holly is obsessed with how many Instagram followers she has. Ollie, a man in his early-20s, suffered severe bullying in his teens, and became absorbed in gaming and

Netflix. Recently, Ollie 'woke up' to what his world had become, Graham says, "and it was so upsetting for him. He felt he'd missed out on relationships, friendships, and all sorts of things that he could see now were what he'd really wanted." All this raises the question: when does a habit become a problem?

Technology addiction is a term that covers addiction to the use of electronic devices, especially smartphones and gaming consoles. Estimates of just how many people are affected vary between studies, from about 2 per cent to 6 per cent, depending on the country and age group. Either way, that equates to at least a million people in the UK alone. And with over-use of gadgets being linked to sleep deprivation, anxiety and depression, that's not good news.

'True' technology addiction, in which a person's brain shows the same kind of

dependency on League Of Legends or checking their Instagram account as that of someone addicted to a drug like heroin, is clearly a big problem for the individuals affected. But it's rare, Graham says, to find someone who has a truly balanced relationship with technology, and with their smartphone, in particular. "What about the rest of us," he says, "walking around, staring at our smartphones, narrowly escaping lamp posts and cars and not able to respond to the people in our lives, or not getting a good night's sleep." Even this level of tech use can interfere with our health, happiness and well-being, he says.

Nonetheless, many of us rely on technology for our jobs, and for staying in touch with friends and family. As Graham readily accepts, technology in the modern world is not only largely unavoidable but often extremely helpful. But in cases of what's termed life 'disruption' rather than 'addiction' – a broader category that surely many of us fall into – strategies designed to help people with technology addiction could help us to use our devices in a healthier way. It's not just addicts who could benefit from a tech detox.

A MODERN AFFLICTION

To understand how devices can get such a grip on us, it's useful to look at research into full-blown addictions. Psychologist Prof Mark Griffiths, the director of the International Gaming Research Unit at Nottingham Trent University, is a pioneer of research in the area. After 20 years of study, he's come to the conclusion that 'internet addiction' and 'smartphone addiction' are really misnomers.

People who are addicted to online gaming, online gambling, online sex, or online shopping are not internet addicts, he argues, but rather gambling addicts, sex addicts or shopping addicts who are using the medium of the internet to engage in their addictive behaviour. For a gaming addict who plays on their smartphone, the structural changes in their brain's reward system that cause cravings are down to the playing of the game, rather than the use of a phone. Repeated exposure to a game (or any other addictive behaviour or drug) causes nerve cells in the nucleus

GETTING HORMONAL

How tech can affect your mood

Scientists have reported strong links between heavy internet use and depression, with a particular focus on social media. This came as no surprise to health education expert Dr Aric Sigman, who says high exposure to social media can leave people feeling inadequate. "There's a relationship between the amount of time you spend on social media and increased body dissatisfaction. High consumption of idealised images activates neural networks in the brain like the amygdala, associated with fear and anxiety."

Sigman cites a study in which girls who instant messaged their mothers released the stress hormone cortisol, rather than the feel-good hormone oxytocin associated with face-to-face interaction. "We may be hard-wired to need a certain amount of contact with people we care about. A deficit in human contact may result in health problems."

So it seems like Facebook might not be giving us enough facetime.

Repeated exposure to a game causes nerve cells in the brain to link liking something with wanting it

accumbens and the prefrontal cortex – areas of the brain respectively involved in motivation and decision-making – to communicate in a way that links liking something with wanting it. In other words, we start to crave it.

Social networking is perhaps one of the few genuine or 'pure' types of 'internet addiction', because there is not an offline equivalent. But here, the addiction is to an app, and as such this kind of compulsion should be understood as 'social networking addiction', says Griffiths.

These distinctions are vital for designing treatments. In the US, Internet Gaming Disorder is now a recognised psychiatric disorder. One former patient on a US 'internet addiction' rehab

ABOVE RIGHT: The reSTART programme offers a rural retreat for people who are addicted to online gaming, social media and gambling

For many of us, though, it's texting, Snapchat, Facebook and other apps that can run on our smartphones, and are always with us, that pose a big problem. One recent survey of smartphone use among US college students, for example, found that 12 per cent identified as 'fanatics' and 7 per cent as 'addicts'. "Our smartphones have turned into tools that provide short, quick, immediate satisfaction," observed Isaac Vaghefi at Binghamton University, who led the study. "Over time this makes us acquire a desire for quick feedback and immediate satisfaction."

A young person with light-colored hair, wearing a red t-shirt with the text "Arsenic Old Love" and blue jeans, stands in a forest. They are holding a large coil of white rope. To their left is a primitive structure made of logs and branches, with a large rock and logs on the ground. The background is filled with dense green foliage and trees.

If checking Instagram, watching Netflix or gaming are encroaching on more and more of your life, it's worth noting Graham's observation that heavy use of one particular type of tech can signal a problem. He highlights "the gamers who keep playing the same game, or people going to the same social media channel, or people who'll start a Netflix boxset and won't be able to stop until it's finished – rather than watching one episode and then changing the channel, or doing something different."

GETTY, RESTART LIFE LLC

UNPLUG YOURSELF

HOW TO LIVE WELL WITH YOUR PHONE

Five tips from Prof Mark Griffiths, psychologist and behavioural addiction expert

1 Step it down gradually

The urge to check your phone can become reflexive and habitual. For some, going a few minutes without checking their phone is difficult. If this sounds like you, try to go 15 minutes without doing it. Once you realise this is possible, increase the length of time you avoid checking to 30 minutes, an hour, then a few hours.

2 Monitor usage

Download an app that will tell you how much time you're spending online. (Moment and AntiSocial are two examples.) This could make you aware of a problem – the first step to a solution.

3 Buy an alarm clock

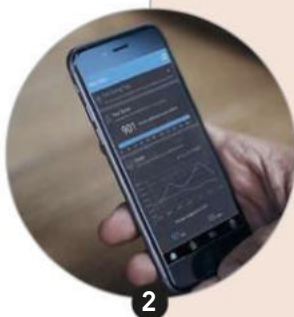
Don't use your phone as an alarm, or you might be tempted to check texts and emails last thing at night and as soon as you wake up. In fact, ban phones from the bedroom. Designate bedtimes and mealtimes as smartphone-free zones. Consider buying a watch, so you're no longer tempted by emails and texts when you check the time.

4 Spring clean your contacts

How many online friends do you actually speak to? Reduce alerts and distractions by deleting contacts on social networks, unsubscribing from groups that offer little benefit, and removing unused apps. And consider deleting any games that are taking up a lot of your time.

5 Learn to wait

Be mindful of the benefits of not regularly checking your phone. People who react to messages as they arrive tend to write longer responses than those who wait and deal with them all as a block. Waiting will gain you time to spend on other activities.



During a 72-hour tech detox, patients report the lows associated with withdrawal from an addictive drug

If your eating habits have become irregular, you're skipping meals, or you're opting for ready meals, so you can quickly get back to a screen, or you're not getting the recommended 30 minutes of exercise a day – these are also indications that tech use may be taking over your life to an unhealthy degree.

You may not be seeing friends as much as you used to, either – but since heavy gamers and social media users will argue that they're interacting with people online, it might be better to focus on the biological signs of a tech problem, Graham suggests. It's also worth noting that there's evidence that online social connections are not equivalent to friendships. One recent study of US adults aged 19 to 32 found that people who reported spending more than two hours a day on platforms such as Facebook, Snapchat and Instagram felt more socially isolated than those who spent half an hour or less on these sites per day.

Identifying a problem is an important step. But the question then is, what's to be done?

DIGITAL DETOX

Some researchers are focusing on the devices themselves. A team at Bournemouth University, for example, is advocating for smart warning labels to be built into devices. These labels could establish time limits for device use, and warn users if they're not sticking to them. Unlike the traditional labels found on tobacco and alcohol, the digital labels could be interactive, changing the colour of the screen when the device has been used for a certain amount of time, for example, or sending personalised messages related to the user's interests.

Apps that can help you monitor time online



or game development. Once they've gotten over that, they feel more rested and more at ease." This allows them to take a more balanced view of the importance of their devices in their lives.

Gadgets will eventually be switched on again. And then the notifications will start up, demanding instant action and attention. "But in the fight of man versus machine, I think being able to put your smartphone down for a few days and just get a sense of what it's actually like to feel different again is really helpful," Graham stresses. And this could help those of us who aren't fully addicted to our devices, too, he says.

The next step is to be much tougher about tech use, and to prioritise the things in life that are truly rewarding, rather than giving in to that instant 'hit'. An approach that's been found to work well in treating depression can be helpful here, Graham says. People who are depressed become more socially isolated and do less of the things that



ABOVE LEFT: Designer Klemens Schillinger has created substitute phones, complete with tactile beads, that he claims can help smartphone users cope with withdrawal by offering physical stimulation (touching, swiping and scrolling) without connectivity

ABOVE: A volunteer undergoing an MRI scan as part of research into gambling addiction

make them feel good, whether that's mountain biking or cooking, painting or playing music. If you can schedule in more of these kinds of activities, as well as more face-to-face time with other people and periods of exercise, you will spend less time with tech. Crucially, these activities will help you feel better about life, too.

This approach can work for those recovering from addiction, as well as the rest of us. "It helps shift the balance," Graham says. "For many, use of technology can slide into something more like the sort of heavy drinker who no longer even enjoys it, but it's become a habit."

It's unlikely that many of us will throw away our smartphones. But recognising when our tech use is excessive, and scheduling in some time away from them could make us all happier. **P**

Emma Young is a science and health journalist and the author of *Sane*.

Find out how Daniel Bennett, *BBC Focus*'s editor, gets on with a fortnight of dramatically reducing his smartphone use at sciencefocus.com/techdetox

are already available, but people with an addiction – or even a life disruption – need more help. With his tech-addicted patients, Graham usually starts with a 72-hour tech detox, which entails complete tech abstinence. This can be tough, and patients often report the lows associated with withdrawal from an addictive drug. The goal of drug rehab treatment, of course, is total abstinence. But since few of us can live without tech, the next step is to reintroduce it, but in a controlled way.

The detox can have a powerful impact, Graham has found. When he started his tech-addiction service in 2010, he anticipated that patients would need to spend extended periods of time in residential programmes. But he's found that if parents (he specialises in treating adolescents) simply take their tech-addicted child away for a weekend or a longer holiday, without any devices, the results can be profound.

After 72 hours or perhaps a week without tech – and with more sleep, and reduced social anxiety – many patients find they can let go of fears of missing out. "It's like stepping off a merry-go-round," Graham explains. "Things will have moved on in the online world – whether that's news feeds or the latest videos trending

BBC

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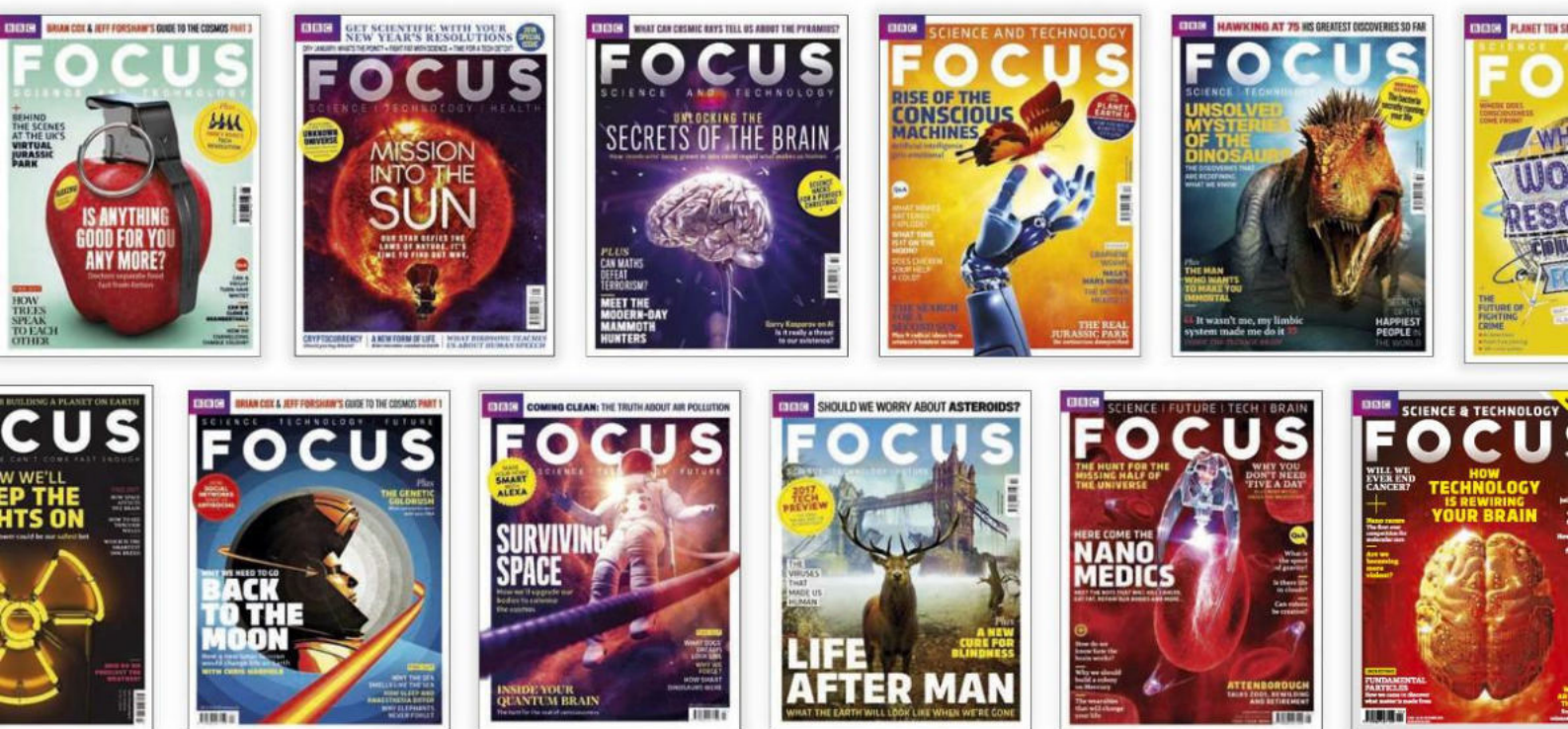
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ALBERT EINSTEIN